



Proceedings of  
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Conference on Electronic  
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# **Proceedings of The Second International Conference on Electronic Business**

*"Global E-Business in Knowledge-Based Economy:  
Management, Practice and Opportunities "*

Edited by

**Chi-Chun Lo,**  
National Chiao Tung University, Taiwan

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# Welcome Messages from Conference Chair

On behalf of the Institute of Information Management of the National Chiao Tung University, I am pleased to welcome you to Taipei and the Second International Conference on Electronic Business. I would like to thank you for choosing to participate in the conference, and hope all of you to find this city full of exciting events, including fabulous Chinese art treasure exhibitions and fascinating night markets.

The Second ICEB conference continues to be a unique venue bringing together leading researchers and practitioners in all areas of e-Business. We have received well over 284 paper submissions and have accepted and included 205 papers in the proceedings. We would like to thank all the authors for submitting to ICEB 2002. This conference provides a major forum for e-Business researchers, practitioners, developers, and users to present their work and discuss critical issues and views on leading-edge e-Business management, practices and opportunities. We certainly hope this conference will provide an excellent overview of the concerns and results of frontier e-business research.

We are greatly honored to announce that Prof. Chun-Yen Chang, President of National Chiao Tung University, has agreed to attend the opening ceremony. Also, three prominent speakers, Prof. Chiang Kao, President of National Cheng Kung University; Prof. Che-Ho Wei, Chairman, National Science Council; and Dr. Quincy Lin, Senior Vice President and CIO, Taiwan Semiconductor Manufacturing Company (TSMC) are going to give keynote speeches in our conference. Prof. Phillip Ein-Dor, Tel-Aviv University, Founding Editor, Journal of AIS; Steve Chang, Founder, Chairman and CEO of Trend Micro Inc.; Prof. Edgar H. Sibley, George Mason University, Editor, Information & Management; and Prof. Po-Lung Yu, Distinguished Professor, National Chiao Tung University will give special presentations in the joint sessions of keynote & panel. Also, seven journal editors, Professors Phillip Ein-Dor, Edgar H. Sibley, G. S. Kuo, Eldon Y. Li, Jos Lemmink, Timon C. Du, and HsiuJu Rebecca Yen have agreed to serve as panelists in the journal editor panel. Moreover, in collaboration with this conference, several journals such as Decision Support Systems and International Journal of Electronic Business, etc., have dedicated special issues/sections for outstanding papers presented in the conference.

The conference would not have been a success without help from so many people. I would like to express my sincere thanks to Faculty of Business Administration, The Chinese University of Hong Kong; Centre for E-Business, National University of Singapore; and Research Center for Contemporary Management, Tsinghua University for co-organizing this conference. I would also like to thank Professors Eldon Li, Jian Chen and Duen-Ren Liu for coordinating paper review, Professors Baoding Liu, Eldon Li, Waiman Cheung, Lihua Huang, and James Ang for promotion and program organization, Duen-Ren Liu for the production of the proceedings, and Ms. Susan Chen for all the administrative supports. Also, I would like to express my deepest gratitude to conference sponsors, National Science Council, Ministry of Education, HP Taiwan, Trend Micro Inc., IBM, Polaris Securities Group, TSMC, UMC, ZyXEL Communications Corp., Computer & Communications Research Laboratories / ITRI, and Institute for Information Industry, Taiwan.

We sincerely hope you experience the warm feeling of hospitality extended by Institute of Information Management, National Chiao Tung University. Finally, enjoy your stay at the Grand Hotel, and the forums provided in the conference.

**Chi-Chun Lo, Ph.D.**  
Conference Chair

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# Keynotes & Panels

## **Keynote Speech: Technology and Management Aspects in Electronic Business**

Prof. Chiang Kao, President, National Cheng Kung University

## **Keynote Speech: Scientific Research in Taiwan**

Prof. Che-Ho We, Chairman, National Science Council, Taiwan

## **Keynote Speech: Challenges and Opportunities of e-Business in the Next Decade**

Dr. Quincy Lin, Senior Vice President & CIO, TSMC, Taiwan Semiconductor Manufacturing Company Ltd

## **Keynote & Panel Discussion I**

### **Keynote: Fifty Years On – Business Computing in 2051**

Prof. Phillip Ein-Dor, Tel-Aviv University; President, Association for Information Systems;  
Founding Editor, Journal of the Association of Information Systems

**Moderator:** Prof. Waiman Cheung, The Chinese University of Hong Kong

**Panelists:** Hemant Jain, Wisconsin Distinguished Professor, University of Wisconsin – Milwaukee;  
Jian Chen, Tsinghua University;  
Chyan Yang, National Chiao Tung University

## **Keynote & Panel Discussion II**

### **Keynote: A World Safe for Exchanging Digital Information**

Steve Chang, Founder, Chairman and CEO of Trend Micro Inc.

**Moderator:** Dr. Jyh-Sheng Ke, Vice President, Institute for Information Industry, Taiwan

**Panelists:** Shun-I Chu, President, ZyXEL Communications Corporation;  
Wayne Pai, President, Polaris Securities Group;  
Terence Liao, General Manager of Business Critical System and Software Group of HP Taiwan

## **Keynote & Panel Discussion III**

### **Keynote: Problems and Research Aspects of Web Security**

Prof. Edgar H. Sibley, Eminent Scholar, George Mason University; Editor, Information & Management

**Moderator:** Dr. Bao-Shuh Paul Lin, Vice President & General Director, Computer & Communications Research Laboratories, Industrial Technology Research Institute, Taiwan

**Panelists:** Shrane Koungh Chou, National Chengchi University;  
Baoding Liu, Tsinghua University;  
Jing-Jang Hwang, Chang Gung University

## **Keynote & Panel Discussion IV**

### **Keynote: Human Aspects: An Important Factor for Successful e-Business**

Prof. Po-Lung Yu, Distinguished Professor, National Chiao Tung University;

C. A. Scupin Distinguished Professor, KU Business School, University of Kansas

**Moderator:** Prof. Han-Lin Li, Dean, College of Management, National Chiao Tung University

**Panelists:** James Ang, National University of Singapore;

Ting-Peng Liang, National Sun Yat-Sen University / The Chinese University of Hong Kong

## **Journal Editor Panel Discussion**

**Moderator:** Prof. Eldon Y. Li, Founding Editor, International Journal of Electronic Business

**Panelists:** Timon C. Du, Managing Editor, International Journal of Internet and Enterprise Management;

Phillip Ein-Dor, Founding Editor, Journal of AIS;

G. S. Kuo, Editor-in-Chief, IEEE Communications Magazine;

Jos Lemmink, Editor, International Journal of Service Industry Management;

Edgar H. Sibley, Editor, Information & Management;

HsiuJu Rebecca Yen, Managing Editor, International Journal of Internet Marketing and Advertising

## **Industrial Presentation: What is e-Business? And Why is it crucial to the future success of your business?**

Dr. Mike H. C. Lee, President & COO of Com2B Corp.

# Keynotes

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# Technology and Management Aspects in Electronic Business

Chiang Kao

President of National Cheng Kung University, Tainan, Taiwan

Technology has been considered by most people as a key factor to the success of economic development of a country and productivity improvement of an industry. An argument is that without the support of sound management systems, the contribution of technology would be limited. In an empirical study, it is found that the productivity of the machinery firms in Taiwan is affected by both technology and management. The mathematical relation is  $Productivity = 1.7836(Technology)^{0.0449}(Management)^{0.3357}$ . The exponent of Management is approximately 7.5 times of that of Technology, indicating that the former is 7.5 times effective than the latter in improving productivity. With that equation, a firm is able to derive suitable strategies to improve productivity taking into account the constraint on time and budget. The same concept should be applicable to Electronic Business. A research topic will be developing proper measurements for technology, management, and performance indicators for Electronic Business.

## **Fifty Years On – Business Computing in 2051**

Phillip Ein-Dor

Professor and Chair of New Economy Information Systems

Faculty of Management

Tel-Aviv University

eindor@tau.ac.il

It is now just over 50 years since the deployment of LEO – the first business computer and application – in 1951. This presentation will attempt to look 50 years ahead in order to discern the nature and effects of business computing in 2051.

Scenarios will be offered of some possible business applications fifty years hence. These include the business information systems in space, the nature of manufacturing, and social effects.

The scenarios will serve as a basis for addressing a number of issues. These include the availability of technology to support the scenarios presented, the nature of organizations shaped by future information systems, the nature of employment in the new organizational structure, consumer-vendor relations in the new economy, the effects of the new information technology on the nature of national governments, and the effect of information technologies on the structure of the global economy.

## **Problems and Research Aspects of Web Security**

Edgar H. Sibley

University Professor, Eminent Scholar  
Information and Software Systems Engineering  
George Mason University  
esibley@gmu.edu

There are many different users of Web technology today, from people buying through electronic commerce systems to those using collaboration technology to work at a distance. Users assume a safe and uninterrupted session. The consequence of hackers, crackers, and denial of service attacks therefore becomes a major problem to organizations today. Research in the field is, however, complex and sometimes difficult.

The Keynote Speech will therefore deal with secure systems research, including:

- The difficulty in setting up a laboratory to perform such research and defining "normal" and "abnormal" traffic, tagging one so that it can be identified when analyzing the flow, both in front of and behind the firewall of an enclave;
- The detection of and partial relief from such attacks as mail bombs, viruses, and Distributed Denial of Service;
- Providing safe conversations across country boundaries for situations needing disclosure of material at designated times to participants; and
- Policy aspects that control such operations and their analysis.

# Human Aspects: An Important Factor for Successful e-Business

Po-Lung Yu

Distinguished Professor, National Chiao Tung University

C. A. Scupin Distinguished Professor, KU Business School, University of Kansas

yupl@cc.nctu.edu.tw

Information technology has changed the landscape of doing business, streamlined the information processing and changed the logistics of the flows of information, materials, cash and product designs of product and service. In this increasingly competitive business world, information technology plays a vital role in business management. However, decision making, strategic planning, consuming and designing are done by humans. If the products or services cannot satisfy the customers' needs or release their pains and frustrations, the product and service could not sell. The business will fail.

In order to have a competitive edge, a company must be able to have insight into potential customers' needs both currently and in the future. A business must understand customers' real pains and desires and produce and deliver products or services that satisfy their needs and relieve their pains and frustrations. In order to reach such a state of competitiveness, a company must become insightful about potential customers' needs and changes in those needs. In addition, it must have maximum flexibility and liquidity to reorganize resources—including human resources, skills, and information—to produce excellent, low-cost goods and services that satisfy the customers' needs ahead of its competitors. A company can compete and survive only by continuously renovating and improving. The company needs to be effective and efficient to design and produce products or services with a lower cost but higher quality. To do so, the company needs to continuously innovate in all areas, including designing, production skills, production procedures, channels of distribution, services and management reengineering, etc., so that it can be ahead of its competitors.

Our thoughts and thinking paradigms are represented by circuit patterns of our billions of neuron cells. These circuit patterns are our mental programs or human software, which drive our brains (a very super computer) to work. The totality of these circuit patterns and their operation are known as our habitual domains or human software. Our habitual domain or software goes with us wherever we go and has a great impact on our behavior and on our competitiveness. We can say that in ever-intensifying competitive situations, the key factor for organizations, industries, societies or nations to succeed and prosper is to continuously upgrade, expand and enrich their competence or habitual domains.

In this talk, we will introduce the concepts of behavior mechanism and habitual domain as to show how we can continuously innovate, enrich and upgrade our competence and competitiveness as to prosper in this very competitive e-era business.

# Paper Sessions

## Session 1A: e-Service & Service Operations on the Web

### **Building E-Service Systems: From Planning to Implementation**

Hiroshi Tsuji, Osaka Prefecture University  
Masato Terada, Hitachi Ltd.

### **Cost and Benefit Analysis for E-Service Applications**

Jie Lu, Guangquan Zhang, University of Technology, Sydney

### **Internal Customer Service: The Potential for E-Service**

Simon Croom, Robert Johnston, University of Warwick

### **In-Depth Revealing Grid Based Web Service Provision Model: Grid Service Provision (GSP)**

Huinan Xu, University of Surrey  
Xiaoming Cong, University of Luton  
Phil Seltsikas, University of Surrey  
Kaushik Pandya, University of Luton

## Session 1B: Collaborative Commerce & Group Support

### **Planning and Deployment of Collaborative Commerce: A Conceptual Framework**

Ta-Tao Chuang, Gonzaga University  
Kazuo Nakatani, Florida Gulf Coast University

### **Reciprocal Effect of Team Commitment and Media Richness in eCollaboration: A Conceptual Model**

Suprasith Jarupathirun, Hemant Jain, University of Wisconsin – Milwaukee

### **Building and Managing Social Capital in Virtual Communities**

Shafiz A. Mohd Yusof, Liaquat Hossain, Syracuse University

### **Research on Role-Centric Collaborative Technology**

Wei-Dong Zhao, Bin Cai, Fudan University

## Session 1C: SCM & e-Logistics

### **Perceived Importance of Success Factors of Firms Practicing E-Logistics in Supply Chain: An Exploratory Study on Extranet**

Wing S. Chow, Hong Kong Baptist University

### **Collaborative Integration between IT Industry and Logistics Industry in Taiwan: A Case Study on T Company's E-Logistics Plan**

Huei-Huang Chen, Yu-Chung Hung, Ching-Chuan Hsieh, Tatung University

### **Impact of Information Sharing in Supply Chain Management**

Takahiro Tsuksihama, Hitachi, Ltd  
Hisashi Onari, Waseda University  
Toshimitsu Hamada, Nasu University

### **Upstream R&D Competition and Cooperation in a Two-Tier Supply Chain**

Pei-Jun Huo, Jian Chen, Tsinghua University  
Ji-Xiang Chen, Shanghai Jiao Tong University

## **Session 1D: Decision Support & Intelligent Systems**

### **A Decision Support System for Construction Project Risk Assessment**

Shih-Tong Lu, National Central University

Gwo-Hshiung Tzeng, National Chiao Tung University

### **An On-Line Personalized Promotion Decision Support System for Electronic Commerce**

Chin-Feng Lee, S. Wesley Changchien, Yu-Jung Hsu, Chaoyang University of Technology

### **Efficiency Increase of Export On-Line Systems by Applying Multiple Criteria Decision Support Systems**

Arturas Kaklauskas, Edmundas Kazimieras Zavadskas, Vilnius Gediminas Technical University

Antanas Zenonas Kaminskas, Lithuanian Government

Vaidotas Trinkunas, Jurate Kaklauskienė, Vilnius Gediminas Technical University

### **A Detailed Procedure for Using Copulas to Classify E-Business Data**

Victor L. Berardi, B. Eddy Patuwo, Michael Y. Hu, Kent State University

## **Session 1E: Technology Management**

### **Measuring IT Contribution to Company's Competitive Advantages**

Edward Cheong-Tsair Ho, Harchand Singh Thandi, Swinburne University of Technology

### **Collectivism, Machiavellianism, Perceived Organizational Justice and Organizational Citizenship Behavior: An Empirical Study of Chinese Employees**

Ruolian Fang, Vivien K.G. Lim, National University of Singapore

### **Applying Business Models for Risk Management in E-Business**

Andrew Finegan, RMIT University

### **Implications of Virtual Interviews as a Global Recruitment Tool**

Stevina Evuleocha, California State University, Hayward

## **Session 1F: Internet Marketing**

### **The Internet Shopping Process: An Empirical Model, Research Findings, and Financial Implications**

Tung-Zong Chang, Su-Jane Chen, Metropolitan State College

### **Internet Advertising: A Comparison of Pricing Strategy**

Seng-Su Tsang, Jung-Kuo Chuang, Yuan Ze University

### **4Ws E-Marketing Strategy: A Conceptual Framework of its Antecedents and its Consequences on Web Performance**

Luís Filipe Lages, Universidade Nova de Lisboa

Carmen Lages, Paulo Rita, ISCTE- Instituto Superior das Ciências do Trabalho e da Empresa

### **Consumer Perceptions of Traditional and Electronic Markets**

Nitaya Wongpinunwatana, Thammasat University

Chanchai Buratavorn, Bank of Thailand

Panchama Vipamas, Siam Steel Cycle Company Limited

Sorajak Jantarabenjakul, Bank of Thailand

## **Session 2A: e-Business Entrepreneurship**

### **E-Government Deployment for the 21st Century**

Manual Avitia, Jonathan Lee, California Polytechnic & State University

### **E-Government and Lessons from E-Commerce: A Preliminary Study**

Grace Zhaohui Liu, American Management Systems, Inc.

Russell K.H. Ching, Nancy Tsai, California State University, Sacramento

### **Taxation of Electronic Commerce**

Peter Horn, L' Ecole Nationale des Ponts et Chaussees

### **The Systematic Thinking on the Development of Chinese E-Business**

Shanchong Shi, Tianjin University

Zhanping Zuo, Kuan Han, Hebei University of Economy & Trade

## **Session 2B: Electronic Commerce Management**

### **A New Business Model of Electronic Commerce with Innovative Strategies**

Ming-Hsien Yang, Wen-Shiu Lin, Mei-Hua Fan, Shang-Chia Liu, Fu-Jen Catholic University

### **A Measurement Model of Trust in Internet Stores**

Liping Liu, Cathy C. Li, University of Akron

Steven J. Karau, Southern Illinois University

### **Designing E-Commerce Product Innovation Strategies to Disrupt Existing Industries**

George M. Puia, Saginaw Valley State University

Xiaohua Yang, Bond University

### **Classifying E-Commerce Trust Seals: An Analytical Framework**

Te-Wei Wang, Chih-Chen Lee, Ena Rose-Green, Florida International University

## **Session 2C: SCM & e-Logistics**

### **Collaboration: Spirit of Supply Chain Management**

Babak Akhgar, Jawed Siddiqi, Saadat M. Al-Hashmi, Sheffield Hallam University

### **The Impact of Internet-Based Technologies on the Procurement Strategy**

Margaret L. Sheng, National Chi Nan University

### **Integrate the Information Technology with Supply Chain Management: A Trend of the Electronic Business in the New Century**

Liuying Yin, Youle Fan, South China University of Technology

### **Some Models for Understanding the Incentives for Supply Chain Collaboration**

Henry C. Co, California Polytechnic & State University

Sharafali Moosa, National University of Singapore

## **Session 2D: Decision Support & Intelligent Systems**

### **A Multiple Criteria Decision Support Web-based System for Facilities Management**

Edmundas Kazimieras Zavadskas, Arturas Kaklauskas, Vilnius Gediminas Technical University

Antanas Zenonas Kaminskas, Lithuanian Government

Andrius Gulbinas, Natalija Lepkova, Jurate Kaklauskienė, Vilnius Gediminas Technical University

**The Design of a Web Snapshot Management System for Decision Support Applications**

David Chao, San Francisco State University

**Group Decision Making for a Fuzzy Software Quality Assessment Model to Evaluate User Satisfaction**

Shu-Yen Lee, China Engineering Consultants, INC.

Tsung-Yen Lee, National Taiwan University

Yeh-Jui Fey, Ling Tung College

Huey-Ming Lee, Chinese Culture University

**Development of a DSS to Estimate the Sales for the Retailing Industry in Taiwan**

Ching-Chin Chern, David Ming-Huang Chiang, National Taiwan University

Ting-Wei Ho, Industrial Technology Research Institute

**On the Accuracy of Judgments in the AHP**

Hong Ling, Limin Lin, Mingxing Han, Lianliang Tan, Fudan University

**Session 2E: Technology Management**

**Reexamining the Benefits of Information Systems in Japanese Manufacturing Companies**

Osam Sato, Tokyo Keizai University

Yoshiki Matsui, Yokohama National University

**An Empirical Study of Business Strategy and Performance**

Choong Y. Lee, Pittsburg State University

**Reconsidering Adoption Behavior: Models Beyond Diffusion**

Steven J. Dick, Southern Illinois University

**Taiwan Internet Diffusion: An Empirical Study of Internet Interactive Effects**

Hsiang-Chi Huang, Institute for Information Industry

**Allying BPR with Strategy: A New Perspective for BPR**

Xiao-Xia Huang, Shao-Zu Mei, University of Science and Technology Beijing

**Session 2F: Internet Marketing**

**Optimal Online Interactive Service Policy and Pricing Decision with Negative Network Externality**

David C. Teng, David M. Chiang, National Taiwan University

**Use of Graphic Images and Text Characters in Internet Banners as an Effective Marketing Tool**

Eric Kin Wai Lau, City University of Hong Kong

**Why People Forward Emails to Others?**

Tom M. Y. Lin, Heng-Hui Wu, National Taiwan University of Science and Technology

**Motivation and Consumer Knowledge on Processing Online Advertisement**

Alex Wang, Emerson College

**Cyber-Marketing will Become the Mainstream of E-Commerce Development in Future**

Xuping Jiang, Tsinghua University

Aiqun Yao, Agriculture University of China

### **Session 3A: e-Business Entrepreneurship**

#### **E-Business Investment in the Travel Industry: A Preliminary Study**

Sophia Wang, National Dong Hwa University  
Waiman Cheung, The Chinese University of Hong Kong

#### **A Proposed Framework for Influencing Factors of Partnership in E-Marketplace**

Hsueh-Foo Lin, National Pingtung Institute of Commerce  
Shin-Yi Lai, China Development Industrial Bank  
Fu-Hsuan Ting, Makalot Industrial Co., Ltd.

#### **Winning in Digital Economy**

Nikhil Agarwal, A.M Sherry, Institute of Management Technology, Ghaziabad

#### **'Do It Yourself (DIY)' E-Business Solutions for Small and Medium Enterprises**

George Q. Huang, JB Zhao, University of Hong Kong

### **Session 3B: Electronic Commerce Management**

#### **A Loss-Free Micropayment Protocol for Multimedia Services**

Jing-Jang Hwang, Chang Gung University  
Jung-Bin Li, National Chiao Tung University

#### **Planning and Decision-Making Process of a Strategic IT Investment: A Case of a Web Content Management System in a Financial Organization**

Petri Hallikainen, Hilikka Merisalo-Rantanen, Kari Nurmimäki, Helsinki School of Economics

#### **An Example of E-Commerce Platform in Anhui Tobacco Corporation**

Bin Ding, Xiaojian Chen, Qinglong Tang, Xiaomin He, University of Science and Technology of China

#### **ePrice Comparator: An Automated Internet Price Comparison System**

Drew Hwang, California State Polytechnic University  
Amy Chen, ACME Portable Machines, Inc.

### **Session 3C: SCM & e-Logistics**

#### **The Impact of Early Order Commitment on the Performance of a Simple Supply Chain**

Xiande Zhao, The Chinese University of Hong Kong  
Jinxing Xie, Tsinghua University  
Jerry C. Wei, The University of Notre Dame

#### **Multiple Objective Planning for Production and Distribution Model of Supply Chain: Case of Bicycle Manufacturer**

Gwo-Hshiung Tzeng, Yu-Min Hung, Min-Lan Chang, National Chiao Tung University

#### **E-Supply Chain Integration for Inter-Enterprise Business Practices**

Chian-Hsueng Chao, National University of Kaohsiung

#### **The Integration of the Third Party Information Resources: The Informationalization Breakthrough for Enterprises Based on the Star Supply Chain Management**

Bo Jiang, Nan He, Na Zhao, Zhao Zhao, Xin-Lu Yang, Northern Jiaotong University

### **Session 3D: Decision Support & Intelligent Systems**

#### **Modeling Decision Systems via Uncertain Programming**

Baoding Liu, Tsinghua University

#### **A Kind of Parallel Evolutionary Algorithms and Its Application in E-Business**

Yan Zhu, Jian Chen, Tsinghua University

#### **The Evolution of Internal Representation**

Ray Tsaih, Wen-Chyan Ke, Chia-Yu Liu, National Chengchi University

#### **A Feature Weighting Method by Multimedia Data Model on E-Business**

Young-Jun Kim, Cheonan College of Foreign Studies

### **Session 3E: Information Technology & Management**

#### **A Comparative Research on Competitiveness of Information Industry of China vs. Korea**

Chang'en Zheng, Yimin Han, Qiwen Wang, Peking University

#### **Standard Single Data Table Web Management Information System Through ASP**

Yuan-Hsi Hsu, Feng Chia University

#### **The Role of the Relational Database Model in E-Business**

Terrence D. Quinn, California Polytechnic & State University

#### **Application Service Provisioning in SMEs: The Tough Job after the Hype**

Marco Cantamessa, Emilio Paolucci, Politecnico di Torino – DSPEA

Davide Tosco, Istituto Superiore Mario Boella

#### **ENAT-PT: An Enhanced NAT-PT Model**

Li-An Zeng, Zhao-Hui Cheng, Li Ling, Songrong Qian, Xu Liao, Fudan University

### **Session 3F: Service Quality & Customer Relationship Management**

#### **A Virtual Prototyping Application (Let Customers Reveal Their "True" Preference)**

Lionel Wang, Marketing and Innovation, L.L.C

#### **Impact of Electronic Commerce Customer Relationship Management on Competitive Advantage: A Research Model and Issues**

Timothy Paul O'Keefe, Assion Lawson-Body, University of North Dakota

Abdou Illia, Eastern Illinois University

#### **Why are Self-Service Customers Loyal? -- A Relational Benefits Perspective**

HsiuJu Rebecca Yen, Yuan-Ze University

#### **CRM Implementation in PR China: A Preliminary Evaluation**

Satya P. Chattopadhyay, University of Scranton

### **Session 4A: e-Business Entrepreneurship**

#### **A Holistic Approach for E-Business Engineering**

Holger Luczak, Stefan Bleck, Tomaso Forzi, Peter Laing, Aachen University of Technology

#### **eBPS: A Strategic Framework for Successful Blueprint of E-Business Development**

Irene S.Y. Kwan, Lingnan University

**The Key Successful Factors of Internet Business: The Study of Online Bookshop**

Shu-Fang Chen, Dauw-Song Zhu, Tzy-Wen Tang, National Dong Hwa University

**Study on the Present Condition, Tendency and Countermeasure of E-Business in China**

Jianzhong Xu, Yunxiu Peng, Bing Li, Harbin Engineering University

**Session 4B: Electronic Commerce Management**

**A SMIL-Based Catalog Presentation System in Electronic Commerce**

Sheng-Tun Li, Hung-Chi Chen, Huang-Chih Hsieh, National Kaohsiung First University of Science and Technology

**Influences of New Trend in Development of American and Canadian E-Business upon Mainland Enterprises and Our Development Strategies**

Danyang Zhu, Guangdong Textiles Imp. & Exp. Corp.

**Tourism Website Development and User Requirements: Who are Tourism Website Users and What are Their Requirements in China**

Zi Lu, Hebei Teacher's University; University of Technology, Sydney

Jie Lu, University of Technology, Sydney

**The Yield Management of Tourist Enterprises**

Rong Kang, Northwest University, Xi'An

Yue Wu, Shaanxi Supply Industry Group Co. Ltd

Bingyang Liu, Northwest University, Xi'An

**Session 4C: SCM & e-Logistics**

**Inventory Management with the Internet-Based Direct Channel in a Two-Echelon Supply Chain System**

Wei-Yu Kevin Chiang, University of Maryland, Baltimore County

George E. Monahan, University of Illinois at Urbana-Champaign

**The Realization of a Stochastic Optimization Model for the Empty Container Inventory Based on EDI Information**

Xin Shi, Shanghai Maritime University

**A Fuzzy Logic and Genetic Algorithm based Supplier Performance Evaluation Methodology for an Effective Supply Chain**

Rajkumar Ohdar, Pradip Kumar Ray, Indian Institute of Technology

**Inventory Policy Implications of On-Line Customer Purchase Behavior**

Harry Groenevelt, University of Rochester

Pranab Majumder, Duke University

**Common Replenishment Strategies in Supply Chain under Uncertainty Demand Environment**

Huiying Zhang, Min-Qiang Li, Ji-Song Kou, Tianjin University

**Session 4D: Decision Support & Intelligent Systems**

**E-Mail as a Decision Tool for Asynchronous Group**

Hsu-Hsiu Cheng, Jyun-Cheng Wang, Chui-Chen Chiu, National Chung Cheng University

**Definable Strategies and Equilibria for Games**

Michel de Rougemont, University Paris II & LRI-CNRS

**Determining Successful Negotiation Strategies: The Evolution of Intelligent Agents**

Jong Yih Kuo, Fu Jen Catholic University

**Overcoming the Fixed-Pie Bias in Multi-Issue Negotiation**

Raymund Lin, Seng-Cho T. Chou, National Taiwan University

**Session 4E: e-Learning & Innovations in Teaching & Learning**

**E-Learning: A Study of Issues and Perspectives**

Andrew Finegan, RMIT University

**How to Setup a Successful E-Learning System for E-Business**

Tzu-Hsin Yang, Min-Jen Tsai, National Chiao Tung University

**Making a Case for Collaborative Business Planning: Educating Information Management and Systems Graduates for the Knowledge-Based Economy**

Angela Lin, Jonathan Foster, University of Sheffield

**Teaching Internet Entrepreneurship**

Gail Ross Waters, California State Polytechnic University, Pomona

**Teaching a Comprehensive Web Based Application within an IS Curriculum**

David C. Wallace, Illinois State University

**Session 4F: Service Quality & Customer Relationship Management**

**E-Business: Customer Acceptance**

Patrick Jaska, University of Mary Hardin-Baylor

Patrick T. Hogan, Columbus State University

**A Quality of Service Framework for Internet Share Trading**

Hong Xu, Jairo Gutierrez, Qiang Lu, University of Auckland

**Beyond Customer Relationship Management: Selling Chain Management for E-Business Practices**

Chian-Hsueng Chao, National University of Kaohsiung

**Towards Customer Knowledge Management: Integrating Customer Relationship Management and Knowledge Management Concepts**

Henning Gebert, Malte Geib, Lutz Kolbe, Gerold Riempp, University of St. Gallen

**Session 5A: Case Study in e-Business**

**How to Transition from a Traditional to an E-Business Enabled Real Estate Agency**

John Hamilton, James Cook University

Willem Selen, Macquarie University

**Value Creation in E-Business: The Case Study of Trend Micro**

Shih-Chang Hung, Tzu-Hsin Liu, Yee-Yeen Chu, National Tsing Hua University

**Approach to E-Business: A Case Study of Shanghai Tobacco Group Corporation**

Kun Zhao, Donghui Yu, Zhongming Chen, Lihua Huang, Fudan University

**Offline Empowerment: Key to the Success of E-Business in India**

Kalpana Mathur, Dhrupad Mathur, Jai Narain Vyas University

## **Session 5B: Electronic Commerce Management**

### **Cost-Benefit Analyses of Internet Investments**

Michael Holm Larsen, Kim Viborg Andersen, Copenhagen Business School

### **Study on the Search Cost in the Electronic Market**

Jian Chen, Yingxia Lin, Tsinghua University

### **An Intelligent Interface Integrated Services Environment for Electronic Commerce**

Chien-Chang Hsu, Fu-Jen Catholic University

### **The Optimal Ordering Periods for Internet Shopping under Time Dependent Consumer Demand**

Chaug-Ing Hsu, Wei-Chieh Lee, National Chiao Tung University

## **Session 5C: Enterprise Resource Planning**

### **Critical Successful Factors of ERP Implementation: A Review**

Allen J. W. Lian, Jim T. M. Lin, National Central University

### **Integrated Collaborative Planning Within the Supply Chain: The Future of ERP**

Mark Richter, California Polytechnic Pomona University

### **A Case Study of ERP Implementation Issues**

Tom Bramorski, University of Wisconsin-Whitewater

### **A Single Item Lot Sizing with Backorder and a Finite Replenishment Rate in MRP**

Liang Liang, Yugang Yu, Hongying Wan, University of Science and Technology of China

### **ERP is the Key Point of Supply Chain Management**

Xiao Chen, Jiahui Cheng, Tsinghua University

## **Session 5D: Data Warehousing & Data Mining**

### **A Bi-Directional Approach for Developing Data Warehouses in Public Sectors**

Monica Lam, Russell Ching, California State University, Sacramento

### **Query Optimization Techniques for OLAP Applications: An ORACLE versus MS-SQL Server Comparative Study**

Ahmed El-Ragal, Yehia Thabet, Arab Academy For Science and Technology

### **User-Based Web Recommendation System: A Case Study of the National Museum of History**

Kwoting Fang, Jonen Liu, National Yunlin University Science of Technology

### **Clustering Graduate Theses Based on Key Phrases Using Agglomerative Hierarchical Methods: An Experiment**

Jau-Hwang Wang, Ju-Cheng Hsieh, Central Police University

## **Session 5E: e-Learning & Innovations in Teaching & Learning**

### **The Relationships between Individual Differences and the Quality of Learning Outcomes in Web-Based Instruction**

Sherry Y. Chen, Brunel University

**Leveraging Enterprise-Wide Information System's Curriculum to Teach E-Business Concepts**

Paul Hawking, Brendan McCarthy, Victoria University

**An Empirical Study of Knowledge Creation and Interaction in Argumentation Setting**

ChingMiin Duh, YungTA Institute of Technology and Commerce

LiarnRung Wen, Meiho Institute of Technology

**A Study on Using Internet to Implement Constructivist Scaffolding Teaching for "Research Method" Course**

Szu-Yuan Sun, Pei-Chen Sun, Ming-Ching Zeng, F-S Wang,

National Kaohsiung First University of Science and Technology

**Session 5F: Service Quality & Customer Relationship Management**

**Combining Clustering and MCDM Approach for Evaluating Customer Lifetime Value Ratings**

Ya-Yueh Shih, Duen-Ren Liu, Gwo-Hshiung Tzeng, National Chiao Tung University

**Applications of Knowledge-Enabled CRM**

YiChen Lin, Southern Taiwan University of Technology

JrJung Lyu, National Cheng Kung University

ChiuShuang Chan, Southern Taiwan University of Technology

**Analyzing the Functional Frame of eCRM Based on Customer Value**

Bing Liang, Bo-Cheng Chen, Tsinghua University

**Linking Customer Retention to Intelligent Technology: An Optimization Approach**

Li-Shang Yang, University of South Australia

Chaochang Chiu, Yuan Ze University

Arthur Preston, University of South Australia

**Session 6A: Case Study in e-Business**

**Strategic Implementation of E-Procurement: A Case Study of an Australian Firm**

Xueli Huang, Rob Welsh, Edith Cowan University

**Performance Evaluation for 59 Listed Electronic Corporations in Taiwan**

Chien-Ta Ho, Lan-Yang Institute of Technology

**e-beauty: A Successful Model for B2C Business**

Rong Chen, The Chinese University of Hong Kong

Feng He, Shaanxi Normal University

**Payment Barriers in China's B2C Business**

Bin Qiu, Southeast University, Nanjing

Shu-Jen Chen, California State University, Fullerton

**Session 6B: Electronic Commerce Management**

**A Blueprint for Applications in Enterprise Information Portals**

Chyan Yang, Kuang-Ming Chen, Jun-Wei Yu, Chen-Hua Fu, Szu-Hui Wu, Fan-Pyn Liu,

National Chiao Tung University

**Atomicity Implementation in E-Commerce Systems**

Lars Frank, Uffe Kofod, Copenhagen Business School

**English as the Infrastructure Language for a Multilingual Internet**

Garry White, Southwest Texas State University

**Business Integration for the Hospital Medical History Database System by Using the Java Server Page and SQL Technique**

Ching-Liang Su, Song-Nan Hong, Jian-Mu Ke, Zhi-Ying Chen, Da Yeh University

**Session 6C: Operations Strategy for e-Commerce**

**Assessing the Impact of Internet Adoption Levels on Competitive Advantage**

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# Building E-Service Systems: From Planning to Implementation

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## Abstract

For building e-service systems, this paper discusses the difference between traditional system integration and e-service system integration. First, e-service systems should be planned by more than two companies who have different core competences. Second, project manager who builds an e-service system should integrate not only hardware nor software but also digital contents. Third, e-service systems are developed not for cost reduction but for customers' satisfaction. Paying attention to these points, this paper presents components, risks, building procedure, and office role for building e-service systems, and reviews our experiences.

## 1. Introduction

System integration is to build an application system by selecting components and connecting them. It is an important activity for system engineers. It includes system planning, transaction analysis, data base design, function design, implementation, and maintenance.

At current Internet era, there are new views for system integration. For building traditional systems such as banking system and inventory system, water-fall model [1] and rapid prototyping model [5] were well known to the project managers. Then there is the decisive question whether or not traditional project management works also for e-service project. Stoehr, T. provides 99 key success factors for managing e-business projects [9].

From our perspective, the traditional models can not be applied to e-service system integration because of three reasons while the target of e-service system is to transform our current life style and work style to new styles by using Internet technology (IT):

- (1) The e-service should be planned by more than two companies who have different core competences. Some companies have competence for system building while others have competence for electronic payment, logistics, system operation, human resources and so on [2]. In fact, Nikkei newspaper in Japan delivers new alliance articles everyday.
- (2) For building an e-service system, a project manager should integrate not only hardware nor software but also digital contents. Currently a variety of digital contents for education and entertainment are provided. Contents aggregation from a volume of contents

holders is attractive movement for customers [10].

- (3) In general, the traditional systems were developed for restructuring companies' business process [3]. There were chances for cost reduction assessment. Therefore, it is possible to calculate cost analysis for investment. However, e-service systems are developed for customers' satisfaction and their convenience [8]. The price for service is often not decided by its cost but consumers' value [8]. Then we should pay attention on business risk. So, methodology for risk/chance analysis is indispensable for building e-service systems.

Paying attention to these reasons, we develop new framework and concept for physical office for building e-service systems. Without framework, the system integrator misses the project management. With framework, the system integrator can recognize his capability maturity for building e-service systems. Our framework presents the components, the risks, and the procedure for building e-service systems while the e-service creation center is a physical office for an e-service development.

## 2. Components for e-Service System Integration

Let us review the difference on components between the traditional systems and the e-service systems first.

For the traditional system integration, a system integrator selects hardware and software for the system infrastructure. Then he designs application program. For his selection, he has to analyze cost/effect and transaction volumes. Of course, the system integrator may outsource program development resources.

Comparing to the traditional system integration, we have identified four points for the e-service components as follows:

- (1) A project manager should integrate not only hardware and software but also digital contents. Digital contents should be identified widely. In fact, there are digital contents not only for the entertainment and the education but also those for the hotel room reservation and the airline ticket reservation. To integrate a variety of contents from a volume of contents holders is called contents aggregation.
- (2) User interface design is important issue because the user is not a professional person but a general consumer. There are variety of user terminals such as personal computers, mobile phones, personal data

assistant, and internet appliances. Data synchronization among them is an important function for mobile computing. The ubiquitous computing concept that allows us to use computer anywhere and anytime is also important.

- (3) Resource outsourcing is a key factor for early service development and risk sharing. Not only application development but also system operation requires professionals. For the system operation, both iDC(internet Data Center) and customer support center are generally outsourced. A system integrator should understand the core competences of outsourcers and subcontractors, and should evaluate them.

- (4)SLA(ServiceLevelAgreement) is an important concept for pricing. A service integrator should clarify the service level for customers and pay the penalty if the service level is degraded. Sometimes customer may prefer the price to the quality. Excellent quality is not always key factor for service selection nor customer satisfaction. Then SLA becomes a clue for service selection.

We propose the components in our framework as shown in Figure 1: Elements for integration, implementation outsourcing, operation outsourcing, and customers/sales channels. “Aggregation” and “Service level agreement” are keywords for integration.

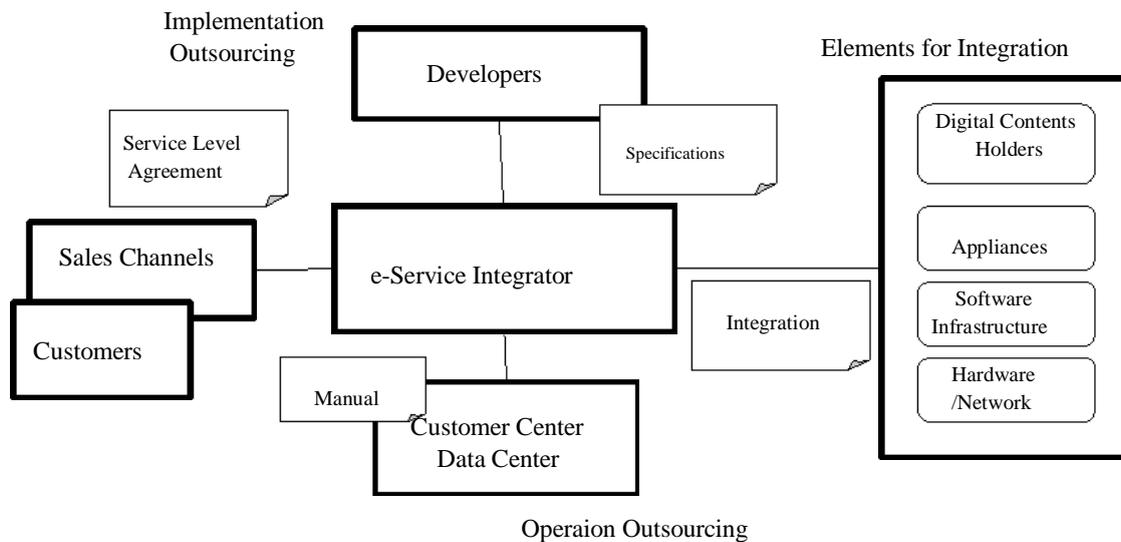


Figure 1. Components for building e-Service Systems

### 3. Risks for e-Service Integration

While e-service is attractive for current era, there are risks for business creation. We should recognize that there should be risks. To avoid risks is meaningless. We should know what the risks are, and what their probabilities of the risk are [11]. To recognize the existence of risk, let us consider the changes in the current market. There are two big changes as follows:

- (a) As mentioned in section 1, most e-services are implemented by more than two companies. Each company has its unique core competence. Figure 2 shows the alliance network among companies for e-service integration. Note that the traditional alliances were done by the companies that have the same (or similar) competence.
- (b) The consumers have gotten the power to collect and deliver information via internet. Sometimes, the consumers make an electronic community to exchange information among special interest group [4]. Without load, time, and money, the internet users are able to know the product differentiation, their inventory, and their price [8].

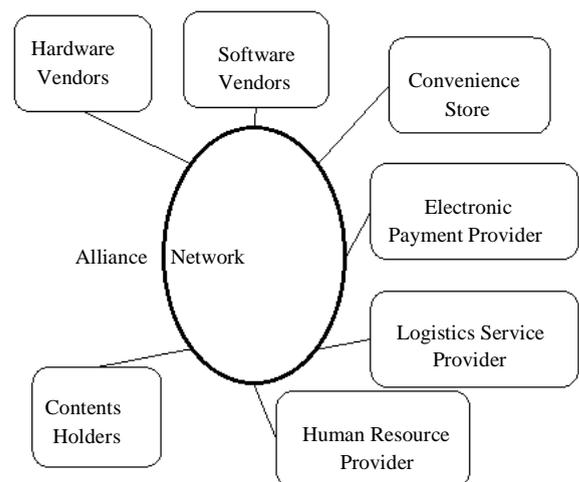
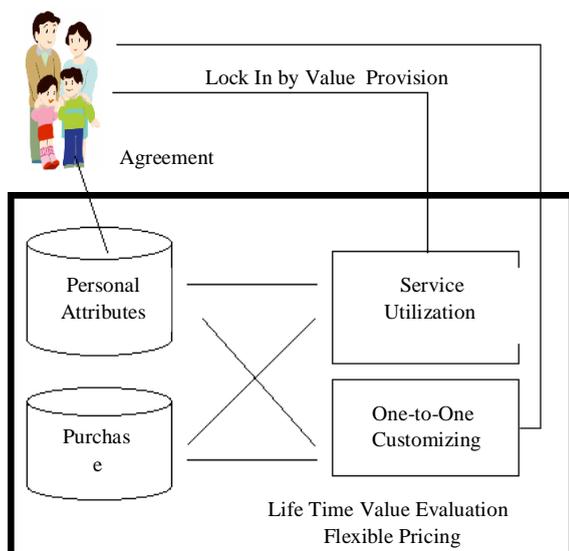


Figure 2 Alliance for Building e-Service Systems.

Understanding these changes, the e-service integrators should create business models. To prevent other company from imitating the new business model, the company should claim business model patents.

For (a), the protocol among allied companies should be defined so that transaction data should be exchanged securely. However, there are few global standards for the service connection. In general, each company has its own system, its culture, its business protocol, and so on. Therefore, there is risk for communication. Further, if a company is declared bankrupt, the business will fail. This is also risk. So a company has means to monitor allied companies status continually.

For (b), we know the price in e-service is decided not by its cost but by its value [8]. The value is defined by customers. Auction site is an example for the electronic community and flexible price. Sometimes, the price is defined by customers LTV (life time value) where LTV is evaluated by total contribution of each customer. However, it is not easy to estimate LTV. Therefore, there is also risk. To estimate LTV as correct as possible, a service integrator build customer database as shown in Figure 3.



**Figure 3 Personal information in e-Service.**

While the customer database stores private information including name, home address, birth date, interests, favorite, purchase history, and so on, there should be privacy protection policy. If the e-service fails to handle privacy information, it will be purged out from the market. Thus, there is risk.

Therefore, the risk management including monitoring, measuring, hedging that has not been necessary for traditional system integration is indispensable for e-business integration.

#### 4. Procedures for e-Service Integration

Based on the discussion in section 2 and section 3, let

us describe our procedure for e-service integration. For building e-service, the business model establishment is the first step. There are three issues in building business model as follows:

- (1) The business model is claimed for the customer satisfaction. The cost/effect analysis that is important in building traditional systems is not possible for starting the e-business. Our framework offers six types of business models: intermediary exclusion model, aggregator model, multi sales channels model, specific service model, cross-sales portal model, and communication portal model. These are discussed elsewhere [9].
- (2) The target customer should be defined. Note that the interest of the aged people is different from that of the young people. Behavior of the married people is different from that of the single people. The life style and the work style should be carefully analyzed. The target customer analysis induces what kind of the user terminal is appropriate for the business.
- (3) The shopping style should be defined. There are three types of shopping: for purchasing daily goods such as books and foods, customers prefer time-saving shopping. For selecting luxurious goods such as dresses, jewels, and watch, the customers would like to enjoy window shopping. They would like to check as many goods as possible even if they are busy. Finally, there is non-daily product shopping. Real estate and car are examples.

Traditionally, the products have been lined up by the company competence (the company's view). In fact, an electronic company provides a variety of electronic equipments while a chemical company provides a variety of goods from oils.

However, the menu of the e-service should be defined by the consumers' view. For example, a consumer who likes driving a car may be interested not only in car information but also in road information, car goods information, and gas station information. Thus, the contents in the e-business should be aggregated not by one company competence but by the consumers' convenience. The followings are example of the e-service vision:

- (a) My company allows working women to live comfortably,
- (b) Our Mission is to give a good circumstance for the aged people,
- (c) We have children learn pleasantly,
- (d) We are happy if the handicapped persons enjoy the internet shopping.

To allow the consumers to handle the contents easily, contents aggregation, ASP (Application Service Provider) aggregation and account aggregation are key factors.

Then business plan should be described. The following should be defined: who are partners? How much is the possible investment? When is the deadline for recovering debts? The business plan should include the annual interest and the accumulated interest.

Currently, a guideline says that the annual interest

should be balanced in three years and the accumulated interest should be balanced in five years. We think it is a reasonable guideline. To calculating the interest, the pricing model and the number of target customer should be assumed.

Then risk/chance analysis is indispensable as shown in Figure 4. The subject in the analysis includes the risk factors of the novelty, the market acceptability, the brand, and the potential market growth. The service integrator should prepare the monitoring method and hedging method for the risks. Assigning the probability to each risk, the service integrator assumes the optimistic scenario and the permissive scenario. The scenarios should be shared among the allied companies and the project members.

Once business model is established, the service integrator should study on the feasibility from the view of the business as follows:

- (1) FS (feasibility test) is promoted for verifying the scenario of the e-business. The service integrator should initiate FS as soon as possible. Then FS is executed as follows: (a) there may be limited service level, (b) the evaluation item is well defined, (c) the period for testing is clear.

The access log that shows the transaction volumes, the transaction bias, the total visitors, the unique visitors, the repeaters behavior and so on is the clue for the evaluation. The test campaign and the event promotion are useful method for measuring customer's reaction.

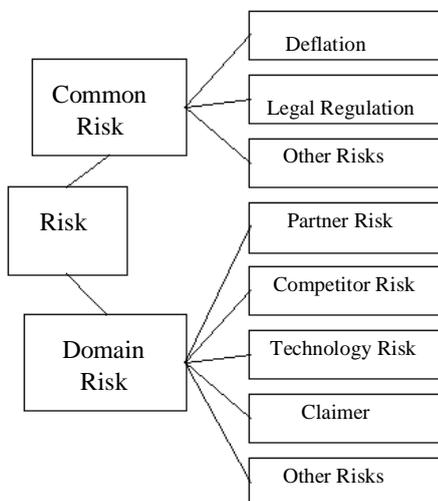


Figure 4 Tree for risk analysis.

- (2) In the case that the FS gets the affirmative result for the business plan, the service integrator designs the service level in detail. The service level including the following items is designed for the business plan: (a) service contents (usability), (b) service time (availability), (c) privacy policy, (d) customer's obligation, (e) disclaimer of warranties, and (f) limitation of liability.
- (3) Using two-dimension axis (free vs. charge, subscription

vs. no-subscription), the framework introduces the evolution process for the e-service. "Repeaters" and "life time value" are the keywords for evolution map. To make new visitors into frequent visitors there should be strategies that provide incentives. The value for the customers should not be evaluated in the short terms. Once an e-service site succeeds to rock in volumes of customers, there will be more chances to get new customers (profit). Figure 5 shows the evolution process for the e-service sites.

- (4) Finally, the service operation policy is designed. The service level designed in step 2 shows the guideline for the computer operation and the customer support operation. The former includes security policy while the latter includes media for the customer channels. Our framework has guideline for the operation outsourcing.

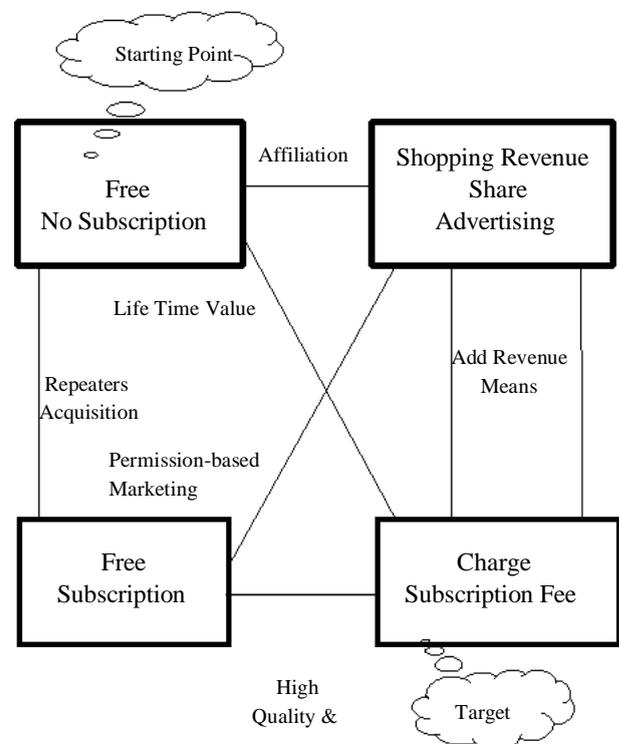


Figure 5 Evolution Transition for e-Service.

## 5. Office for e-Service Development

To integrate the e-service systems by the framework mentioned in the previous section, the physical place plays an important role. Analyzing the requisite of the physical place, we designed e-service creation center. Our e-service creation center that was founded in October of 2000 consists of the meeting rooms, the concept exhibition room, the presentation room and mini iDC (internet data centers). Figure 6 shows the layout of our e-service creation center.

The e-service creation center is open to persons and organizations that are interested in creating e-services. The vendors, the contents holders, the outsourcers, the carriers

and so on are the guests of the center. They exchange their competences, their vision, and their brand in order to create the business ideas at our meeting rooms.

To disclose one's competence and to make business alliances, our concept exhibition room and mini iDC are powerful. The mini iDC that is equipped with fundamental hardware, software and network is ready for starting feasibility study on business idea. The created business idea is introduced at the presentation room. The usability test is also done at the e-service creation center.

The concept exhibition room demonstrates the attraction of CDN (Contents Delivery Network) which allows persons to enjoy rich contents on internet such as streaming media. Then the contents holders who are not accustomed to CDN become to be tempted to deliver their contents via internet. Thus, there are chances for the contents aggregation.

## 6. Conclusion

We have described the e-service integration. We identified the difference between the traditional system integration and the e-service integration. Paying attention the difference, we develop a new framework. However, it is not easy to establish the new project management. In general, any organization has the capability maturity level for project management. To identify the level of the capability maturity is important.

CMM (Capability Maturity Model) presented by CMU [7] shows a guideline for capability maturity. There are five stages in CMM: Inconsistent Management, Project Management, Process Management, Capability Management, and Change Management.

Although in October of 2000 our capability maturity level was "Inconsistent Management" because we do not have know-how on e-service building, our current level of capability maturity is "Project Management" because we have experienced for building e-service [12][13]. For the future work, we will clarify the issues for "Process Management", "Capability Management" (Observable and Controllable), and "Change Management" for the e-service integration.

## 7. Acknowledgement

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## References

- [1] Boem, W.: "Software Engineering", *IEEE Transaction on Computer*, Vol. 25, No.12, pp.1226-41 (1976)
- [2] Choi, S., et al., *Economics of Electronic Commerce*, Macmillan Technical Publishing (1997)
- [3] Hammer, M. and J. Champy: *Reengineering the Corporation*, Harper Business (1993)
- [4] Ishida, T., et al (eds.), *Digital Cities: Technologies, Experiences, and Future Perspectives*, Springer, (2000)
- [5] Kataoka, M., *Software Modeling* (in Japanese), Nikka Giren (1988)
- [6] Menasce, D. and V. Almeida: *Capacity Planning for Web Services*, Prentice Hall PTR (2001)
- [7] SEI of Carnegie-Mellon University: *The Capability Maturity Model: Guidelines for Improving the Software Process*, Addison Wesley Longman, Inc. (1998)
- [8] Shapiro, C. et al., *Information Rules: A Strategic Guide to the Network Economy*, Harvard Business School Press (1998)
- [9] Stoehr, T.: *Managing E-Business Project - 99Key Success Factors*, Springer (2002)
- [10] Tsuji, H., et al. "e-Transformation: Building e-Service Systems", *Proc. of The 6th World Multiconference on Systemics, Cybernetics and Informatics, SCI2002*, pp.163-167 (2002)
- [11] H. Tsuji, H. Mizuno, T. Morita, C. Hirai: "Man-Machine Cooperation in Business Risk Management", *8th IFAC/IFIP/IFORS/IEA Symposium on Analysis, Design, and Evaluation of Human-Machine Systems*, p.309-314 (2001)
- [12] H. Tsuji, K. Fukuda, T. Yasunaga, A. Koshi: "Cafeteria-Style Benefits Plan Service System for Advanced Japanese Company", *The 4th World Multiconference on Systemics, Cybernetics and Informatics*, pp.286-290 (2000)
- [13] Hiroshi Tsuji, Masato Terada, Yuki Kadowaki, Masaaki Tanizaki, Shigeru Shimada: "Spatial Information Sharing for Mobile Phones", *In Digital Cities 2* (M. Tanabe, P. van den Besselaar, T. Ishida ED.), Springer-Verlag, pp.331-342 (2002)

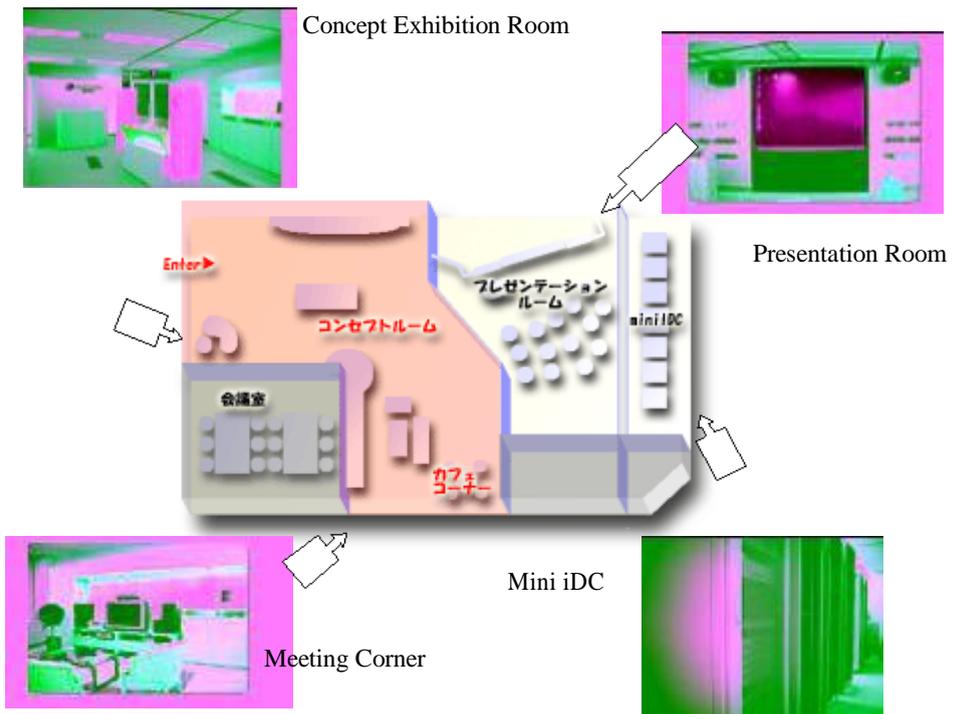


Figure 6 An example layout for e-Service Creation Center.

# Cost and Benefit Analysis for E-Service Applications

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## Abstract

Companies are adopting Internet-based electronic services (E-services) attracting customers, sharing of business information, maintaining business relationships and conducting business transactions. Companies in the earlier stages of employing E-services have little information and knowledge on its potential organizational and relational impacts. Through few years practice of E-services, companies have obtained related knowledge. They urgently need to assess the costs to move service online against the benefits received via adopting E-service, and identify the impact of E-service adoption in companies' relationships with their customers as a result of innovative use of E-services.

The initial objective of the research is to explore the relationships between cost factors, benefit factors and customer satisfaction for an E-service application. A further objective is to find a potential path for developing a customer oriented E-service application from its current implementation through identifying the types of changes taking place in the service functions and operations as a result of increased use of E-services. Though conducting a survey, this paper, as a stage report of the project, presents a research framework for E-service evaluation, identifies main cost and benefit factors of E-service and analyses the relationships between these factors. Finally, a cost benefit relationship model is proposed.

**Keywords:** E-services, Evaluation, Cost benefit analysis, Customer satisfaction, Assessment framework

## 1. Introduction

The Internet is being used as a platform through which services are delivered to businesses and customers [3]. Companies are adopting Internet-based electronic services (E-services) attracting customers, sharing of business information, maintaining business relationships and conducting business transactions. More recently, companies have started using the E-service as means to automate relationships between their business processes to allow customers to form alliances, joining their applications, databases, and systems in order to share their costs .

E-service applications in Australia have had rapid growth in past few years. International benchmarks consistently place Australia among the top ten countries in the world in the terms of adoption and use of E-business (E-service has been extraordinarily affected by the development of E-business). Through assessing connectivity, business environment, E-commerce consumer and business adoption, legal and regulatory environment, supporting an E-service, and social and cultural infrastructure, the US based Economist Intelligence Unit [6] published its second set of "E-business Readiness Rankings" for over 60 countries in May 2001, Australia was placed 2<sup>nd</sup> to the US [22]. As the results presented in 'The current state of play-June 2001' [22], 50% of Australian adults accessed the Internet in the 12 months to November 2000 and 37% of Australian households were connected to the Internet at November 2000 [21]. On business online use, 56% of employing businesses were connected to the Internet at June 2000 (an increase of 93% since June 1998). On the aspect of business E-service activity, the use of online banking and shopping by Australians has grown considerably. An estimated 13% of adults paid bills or transferred funds in the three months to November 2000 (an increase of 225% since November 1999), and 10% purchased or ordered goods or services via the Internet. The value of Internet-based E-service in Australia at June 2000 was estimated to be \$A5.1 billion [22]. The ability of E-service to fulfill customers' demands for service is helping businesses to reduce costs and obtain benefits. Service is an important measure of success in competitive markets and the Internet marketplace will be no exception. As researchers noted, E-business success is determined less by business models than by delivering topnotch, repeatable service that creates satisfied customers [19].

Recent reports concerning the quality, usability and benefits of E-services have led researchers to express increasing interests in conducting evaluation for E-services [9]. These studies used various research methods, such as survey, case study and conceptual modelling, to conduct research in E-service websites or applications assessment, evaluation frameworks, cost/benefit analysis and customer satisfaction measurement. Ng et al. [20] reported a desk survey of business websites and discussed the benefits of Internet. Giaglis et al. [7] presented a case study of E-commerce investment evaluation by developing a model of E-

commerce business value. Tang et al. [25] proposed a conceptual model to demonstrate the rationale of the buyer-supplier interaction with the information service provider's mediation in the E-commerce environment. Lee et al. [13] created a framework for evaluating the business value of Internet-based B2B E-service through five propositions. Helander and Khalid [11] used a system model to illustrate the relationships between three subsystems in E-commerce: store environment, customer and web technology. Drinjak, Altmann & Joyce [5] investigated the perceived benefits of investing in E-service applications. More recently, Hahn et al [10] summarized three major traditional approaches to E-commerce website evaluation: testing, inspection and inquiry, and presented a value-driven framework for E-commerce website evaluation.

However, exist evaluation models and frameworks from literature have orientation either from a web customer perspective or web supplier perspective only. The project intends to explore the relationships between customer perspective and supplier perspective for specific E-service applications. This project attempts to develop a conceptual framework to evaluate E-service applications by identifying the relationships among E-service functions, customer satisfaction for E-service applications, business benefits received via adopting E-service and costs to move service operations to online. It will then identify the types of changes taking place in the service functions and operations as a result of increased use of E-service, examine the impact of increased sharing of information via online collaboration between companies and their customers on management approaches. The research results will be expressed into a factors relationship model. Based on the model, recommendations for developing and maintaining E-service applications will be proposed, which will have the potential to improve the competitiveness, flexibility and strategic planning of companies engaging in E-service by reducing costs, increasing benefits and making E-service activities better.

This paper, as a stage report of the project, describes the research framework in Section 2. Research methodology used in the study is given in Section 3. Section 4 analyses main cost benefit factors and their relationships for the development of an E-service application, and then expresses the findings into a cost benefit relationship model.

## 2. Research Framework

Based on the pervious works shown in Lu at el [17], Lu [15, 16] and a broad range review of literature (such as [5] [8] and [23]), four categories are identified to compose a conceptual research framework for assessing E-service applications. The four categories are E-service function (F), E-service cost (C), E-service benefit (B) and customer satisfaction (S)(FCBS). *E-*

*service function* concerns with the capability and quality of E-services. *E-service cost* concerns with the costs of adopting E-services. *E-service benefit* concerns with the benefits received through employing E-services. *Customer satisfaction* is about the results of individuals taking outcomes that have been received. Each category consists of a set of factors.

The number, types and functions of E-services increase day by day and E-services are typically delivered individually. In *E-service function* category, typical function factors include general information publicity, email require, delivery of customized information, advertising products and price, online ordering/booking and on-line transaction. These functions also imply the levels of E-service complexity. For example, online payment has higher level than only advertising products. Each E-service application may contain several or all of these functions.

Drinjak, Altmann & Joyce [5] listed a number of benefit items within three categories of web applications and their rankings. These items include: providing access 24 hours a day and seven days a week (24\*7), effective promotion of the company together with the products and services it produces, enhance quality and speed of customer service, create competitive advantage and subsequently avoid competitive disadvantage, entice shoppers and encourage customer interaction, supporting core business functions which are integral to business strategy, provide new business opportunities, increase market presence and facilitate on-line purchasing. The research also indicated that the item access 24\*7, effective promotion of the company, enhancing customer service, supporting core business functions, and providing new business opportunities have relatively high rankings. Lu [16] listed 21 benefit factors and identified eight factors as the core benefit factors through a survey conducted in New Zealand. They are: accessing to a greater customer base, broadening market reach, lowering of entry barrier to new markets and cost of acquiring new customers, alternative communication channel to customers, increasing services to customers, enhancing perceived company image, gaining competitive advantages, and potential for increasing customer knowledge. Based on the two research results, 16 main E-service benefit factors are identified and used in the study.

Lu [16] also tested 19 cost factors and identified eight core costs factors: expense of setting up applications, maintaining applications, internet connection, hardware/software, security concerns, legal issues, training and rapid technology changes. The eight cost items are used in the study as cost factors.

E-service is altering the way in which businesses operate and interact with customers. One of the major challenges companies face today is to meet increasing

customer demands, including efficient processes and improved customer services. The judgment on the quality of service has been shifted from the business to the individual customers. Customer satisfaction has become one of the dominant factors to E-service success [4]. As Terry & Standing [26] observed 'while there is no direct measure for the success of an information system, empirical researchers have commonly used user satisfaction as the dependent variable'. A successful E-service is one that attracts customers, makes them feel the service is trustworthy, dependable, reliable, and satisfactory [14] [12].

Generally there are three types of customer measures to be used: the relative importance of attributes, dimension of customer satisfaction and added customer value [1]. *Attribute importance* means every service attribute contributes diversely to the overall satisfaction of the customers. *Dimension of customer satisfaction* means every dimension of satisfaction gets its own score, which then can be compared to evaluate the strengths and weaknesses of the applications. *Added*

*customer value* is generated through dividing the business' overall customer satisfaction by the scores of all businesses competing in a certain market. This project applies a composition of the three types of customer measures in customer satisfaction category. It includes information content satisfaction, usability satisfaction, security satisfaction, convenience satisfaction, efficiency satisfaction and flexibility satisfaction. Each of the factors may imply more detail criteria. For example, usability satisfaction involves user satisfaction in information up-to-date, clear language style and links to appropriate resources. E-service website format design, facilitated browsing, search engine provided, accessing speed and customer control of a transaction process [24] are considered as sub-criteria for convenience satisfaction.

Figure 1 shows the factors of E-service function, cost, benefit and customer satisfaction, called FCBS research framework.

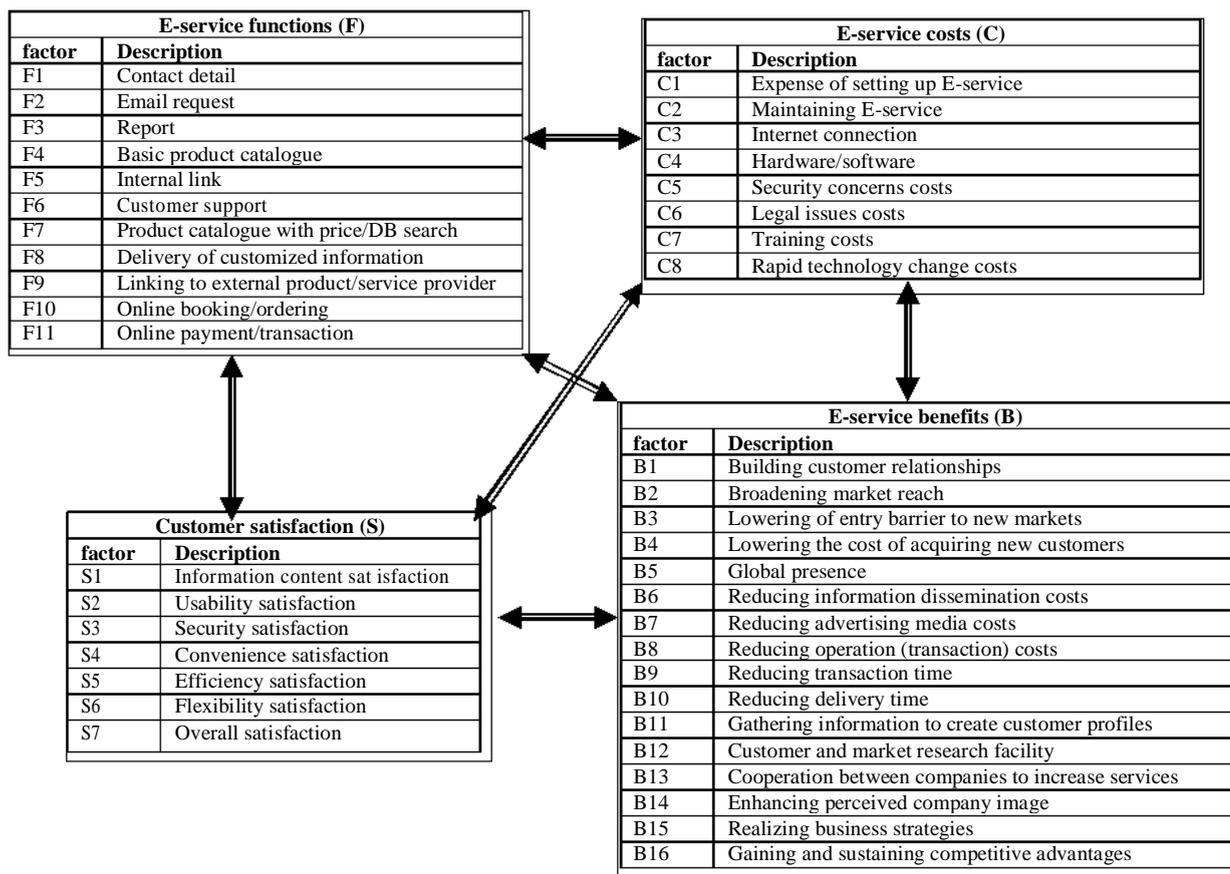


Fig. 1 FCBS research framework with factors

### 3. Research Methodology

This study focuses on two main industry sectors: Tourism/Travel and IT/Communication services in Australia. This study needs to conduct a company (E-service provider) oriented survey and a customer oriented survey respectively. It then explores the relationships among survey results by using statistical analysis method. Why the project develop two surveys is that it needs to get customer satisfaction from customer side and company cost benefit assessment from company side. The statistical analysis aims to find useful aggregation results in investigate dependency and correlation relationships between factors shown in the research framework. The surveys assume that respondents represent their colleagues and should not be asked directly about hypotheses.

In order to identify company sample a *web search* was first conducted. The purpose of the web search is to find which companies have adopted E-services on an appropriate level and get volunteers from these companies. A total of 100 websites were randomly selected from the company websites registered in the Yellow Pages Online (NSW, Australia) <http://www.yellowpages.com.au>, under Tourism/Travel and IT/Communication categories, conditional on their reaching for an appropriate level of E-service development. The sample companies involved a number of industry sectors: Accommodation, Community Services, Information Technology, Retail, Transport, Attractions and Travel Agents.

A *company-oriented questionnaire survey* was conducted in the sample companies from February to March 2002. As a pre-test survey, an initial questionnaire was sent to three subjects aimed getting responses' feedback. Based on the pre-test results, the questionnaire was refined. The finalized questionnaire was then posted/emailed/faxed to the 100 selected sample companies. Out of 34 questions in the questionnaire, eight items are related to E-service functions and development, 10 are related to the costs of setting up and maintaining E-service applications and 16 are related to business benefits of E-service applications. A total of 50 responses were obtained and the results shown in this paper is based on 48 completed responses. All questions listed in the questionnaire use five-point Likert scales or giving a statement that is responded by choosing or not choosing. This survey attempts to identify why companies adopt E-service applications, how do evaluate an E-service application, what are the main benefit factors and what kinds of benefits have been obtained, what are the major costs and barriers towards E-service applications, and how the relationships are changing between E-service costs and benefits.

Finally, a *customer-oriented survey* was conducted in September 2002 to identify customers' major

facilitators and barriers in relation to receive E-services, customers satisfaction in information content, usability, security, convenience, efficient and flexibility for E-services. By the length limitation, the paper only shows the results conducted in the company oriented survey.

### 4. Data Analysis

#### 4.1 Why do companies adopt E-service applications?

The survey results show that the 48 companies sampled have employed Internet doing E-service for 3.1 years on average. There are 49% of the companies sampled indicate the reason to develop E-services is 'currently it is the way to do business', 27% indicate that their competitors are adopting E-services, 41% mention that their customers want E-service based business relationships, and 73% explain that doing E-services is a part of their organization's strategies. Some companies gave more reasons for doing E-services such as this is 'another way to reach new customers', 'online knowledge management' and 'E-service is a cost-effective solution'. One company indicates the reason is that 'we are an Internet technology company'.

#### 4.2 Are companies satisfied with their current E-service applications?

Out of the 48 sampled companies, about 26% of sampled companies think that their E-service applications are 'very successful', 36% of 'successful', 28% of 'moderate', 8% of 'very little' and only one company marked 'not beneficial'. The result shows that most companies are satisfied with their E-service development.

The data shows that about 40% of E-service applications were developed by in-house staff, 20% by web developers or contractors, and 39% by both internal and external people. Through comparing the 'successful' level in the three groups of websites, there is no significant difference in satisfaction levels for E-service applications developed among different groups.

This survey also explored the barriers when company adopting an E-service application. 35% of companies sampled indicate that 'lack of staff expertise' is one of main barriers. 33% indicate 'difficulty in integrating web with internal applications' is a main barrier. 'Expense of setting up E-service' is marked as one of main barriers by 41% of companies. 'Expense of maintaining E-service', 'Lack of adequate training', 'Lack of web capable business partners', 'Resistance to structural changes within your company', and 'Security problems associated with using E-service' are marked as barriers by 16%, 12%, 6%, 14% and 16% of companies respectively. This result shows that expertise, technique, and expenses are still main barriers for E-service development.

It is found that companies that mark their E-service applications as 'very little benefit' or 'not beneficial' almost mark 'expense of setting up web-based E-service applications' and 'difficulty in integrating web with internal applications' as main barriers. This finding means obviously that such companies must overcome barriers in setting up and integrating E-services to obtain ideal benefits.

### 4.3 What functions are provided in E-service websites?

Totally 11 function factors listed in Figure 1 were tested. The results show that over 90% of sample companies provided contact details, reports, basic product catalogue and internal links. About 40% of companies offered online booking and 67% made product catalogue with price/DB search available. Only three companies kept sending information to customers and only seven allowed online payment.

What factors/functions are more important to online customers in their decision to purchase at a website? The survey shows that 51% of companies sampled thinks 'guarantees transaction security' is an important factor. 49% of indicate 'guarantees services or products offered' is important. 67% of indicate 'provides useful information' and 59% of expresses their concerns on 'provides user-friendly navigation to information'. There are 59% of companies marking p' rovides fast service' and 35% of 'provides lower cost than traditional methods'. About 33% of companies mentions that

'provides more options to customer services or products selection' is one of important factors.

### 4.4 What are the main benefits for adopting an E-service?

The questionnaire is designed to cover proposed factors at an appropriate level and with an appropriate form. The respondents were asked to indicate their present benefits assessment and ideal rating for each of the benefit factors. The current benefit assessment is regarding to the assessment of the status of respondents' E-service application, comparing with where they would ideally like it to be. The ideal rating for benefit factors is tested on a 5-point scale. Here '1' means not important at all, and '5' very important. For example, if a company considers that one of the most important benefits is to enhance perceived company image, the company would score perhaps 5 on the Ideal Rating of factor 'enhancing perceived company image'. Table 1 shows the result of ideal rating for benefit factors. It is found that B14 (Enhancing perceived company image), B16 (Gaining and sustaining competitive advantages), B1 (Building customer relationships), B2 (Broadening market reach), B15 (Realizing business strategies) and B4 (Lowering the cost of acquiring new customers) received higher scores respectively. These factors are thus identified as major benefit factors. That means businesses have a higher expects to get benefits on these aspects.

**Table 1: Ideal rating for benefit factors**

Ideal rating	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16
1	0	0	3	1	5	5	3	5	5	5	4	2	4	1	1	1
2	2	4	6	2	7	3	4	3	2	4	5	4	5	2	3	2
3	8	9	9	9	12	6	9	9	6	9	4	11	6	3	8	5
4	10	12	15	16	5	16	15	13	14	6	16	12	11	9	10	8
5	27	21	12	18	17	16	15	15	19	19	15	15	18	30	23	29
NA	0	47	2	1	1	1	1	2	1	4	3	3	3	2	2	2
AV	4.3	4.1	3.6	4.0	3.5	3.8	3.8	3.6	3.9	3.7	3.8	3.8	3.8	4.4	4.1	4.4

### 4.5 What benefits have been obtained through developing an E-service application?

Companies are all interested in maximizing business value of E-services. They have made business strategies to address the requirements of interoperability, quality of customer service, evolution and dependability. They expect to know what factors are affecting E-service benefits and how E-service can increase real business benefits, by comparing its costs with those of the associated investments. In order to complete such analysis, this study not only explores which benefit factors are more important to business benefit and also seeks to find in which aspects companies have obtained

higher benefits, and which one is lower. The 5-point scale is also used for present benefit assessment: 1-low benefit, 5-very high benefit. For example, if a company considers that currently E-service only build very basic customer relationships but the company would ideally prefer to build more closed relationships with customers. Then the company would score perhaps 3 on the present benefit assessment for B1. The assessment result shown in Table 2 indicates that companies have obtained higher benefits on B14 (Enhancing perceived company image), B16 (Gaining and sustaining competitive advantages), B1 (Build customer relationships) and B2 (Broadening market reach).

**Table 2: Current benefit assessment**

Benefit assessment	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16
1	2	1	6	4	9	5	6	7	7	7	10	9	7	1	3	2
2	7	6	13	14	10	8	7	7	10	9	7	12	8	5	7	8
3	16	21	18	14	8	17	13	18	12	13	10	17	12	12	18	15
4	14	12	7	9	13	12	15	8	10	8	14	3	13	12	12	12
5	9	8	3	6	8	5	6	7	9	9	5	5	6	17	7	10
NA	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0
AV	3.4	3.4	2.7	3.0	3.0	3.1	3.2	3.0	3.1	3.1	2.9	2.6	3.1	3.8	3.3	3.5

**4.6 What are the main cost factors for adopting an E-service application?**

Same as benefit factor identification, this study identifies major cost factors by 5-point scale: 1- not important at all, 5- very important. For example, if a company thinks the cost of maintaining an E-service is not important it should mark the degree of importance as 1 or 2. Table 3 shows that C2 (Maintaining E-services) is the most important factor and C5 (Security concerns costs) is the second as they received a high average value (3.9, 3.7). This finding implies that companies have had or would have higher investment on these important cost items.

**Table 3. Weights of cost factors**

weight	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
1	4	1	4	2	3	8	4	4	4	5
2	6	7	8	5	7	6	9	4	2	4
3	10	7	12	13	7	10	10	15	13	17
4	13	15	11	16	10	11	17	14	20	12
5	14	17	12	9	18	10	5	10	8	9
N/A	0	0	0	2	2	2	2	0	0	0
AV	3.6	3.9	3.4	3.6	3.7	3.3	3.2	3.5	3.6	3.3

**4.7 What costs are higher than estimated in developing an E-service application?**

This study also explores which items cause a higher cost, and which one lower. Here ‘1’ means very low cost, and ‘5’ very high. The assessment result is shown in Table 4. It is found that there are higher costs on C9 (time spent on E-service development) and C1 (expense of setting up E-service) in the sampled companies.

**Table 4. Current cost assessment**

cost	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
1	6	6	15	5	7	9	9	8	6	6
2	5	10	13	7	9	12	9	7	3	8
3	10	12	11	16	9	11	15	9	13	14
4	17	16	7	12	13	8	10	19	14	14
5	9	3	1	7	7	4	2	3	10	4
N/A	0	0	0	0	2	3	2	1	1	1
AV	3.4	3.0	2.3	3.2	3.1	2.7	2.7	3.0	3.4	3.0

**4.8 What cost factors affect E-service benefits?**

In order to exam the relationships between individual cost and benefit factors, a number of hypotheses are designed [18]. This paper only presents three hypotheses and discusses related test result details.

**H1:** There is a significant difference in the benefit 'Broadening market reach' (B2) for different groups of companies that have different levels in the cost of 'Maintaining E-service' applications (C2).

**H2:** There is a significant difference in the benefit 'Gaining and sustaining competitive advantages' (B16) for different groups of companies that have different levels in the cost of 'Maintaining E-service' applications (C2).

**H3:** There is a significant difference in the benefit 'Enhancing perceived company image' (B14) for different groups of companies that have different levels in the 'Legal issues costs' (C6).

Let 'Maintaining E-service' (C2) be an independent variable with five levels, 'B' roadening market reach' (B2) and 'Gaining and sustaining competitive advantages' (B16) be dependent variables. Let 'Legal issues costs' (C6) be an independent variable with five levels, 'Enhancing perceived company image' be a dependent variable. Three one factor fixed effects ANOVA models (1), (2) and (3) were built to determine the effect of the independent variables on the dependent measures in individuals.

$$[Broadening\_market\_reach]_i = \alpha + \beta [Maintaining\_E-service]_i + e_i \quad (1)$$

$$[Gaining\_compet\_advantages]_i = \alpha + \beta [Maintaining\_E-service]_i + e_i \quad (2)$$

$$[Enhancing\_perceived\_company\_image]_i = \alpha + \beta [Legal\_issues\_costs]_i + e_i \quad (3)$$

The ANOVA results show that the 'Broadening market reach' and 'Gaining and sustaining competitive advantages' are significantly different across different groups of the cost of 'Maintaining E-service' ( $p < 0.05$  in Table 5 and 6). The findings mean that the E-service applications where company spent more time on maintenance will contribute directly to the benefit factors B' roadening market reach' and G' aining and sustaining competitive advantages'. The result supports H1 and H2. However, Table 7 shows that the 'Enhancing perceived company image' is not significantly different across different groups of the cost of 'Legal issues costs'. It is not support H3's claim.

**Table 5. Summary & ANOVA results for the effects on Broadening market reach (B2)**

Cost 2 groups	Cont	Sum	Ave	F	P-value
C2=1 very low	6	21	3.5	2.7	0.0461
C2=2	10	27	2.7		
C2=3	12	43	3.5		
C2=4	16	55	3.4		
C2=5 very high	3	14	4.6		

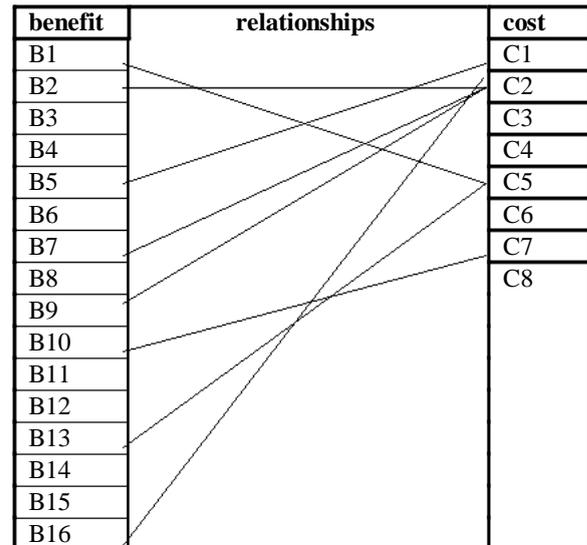
**Table 6. Summary & ANOVA results for the effects on Gaining and sustaining competitive advantages (B16)**

Cost 2 groups	Cot	Sum	Ave	F	P-value
C2=1 verylow	6	16	2.7	5.3	0.0015
C2=2	9	27	3.1		
C2=3	12	36	3		
C2=4	16	67	4.2		
C2=5 veryhigh	3	14	4.7		

**Table 7. Summary & ANOVA results for the effects on Enhancing perceived company image (B14)**

Cost 6 groups	Cont	Sum	Ave	Source of variation	df	MS	F	P-value
C6= 1 very low	9	34	3.78	Between Groups	4	2.7	2.4	0.0643
C6= 2	12	40	3.38	Within Groups	38	1.1		
C6= 3	10	43	4.3					
C6= 4	8	36	4.5					
C6= 5 very high	4	12	3					

By using ANOVA model to test other hypotheses, a set of relationships between cost and benefit factors are explored. The results are presented in a cost benefit relationship model (Figure 2). The lines in the model express dependency relationships between related factors.



**Fig. 2. Relationships between cost and benefit factors**

## 5. Further Research

This study is applying Structural equation modeling method [2] to analyze the relationships between multiple cost benefit factors.

This study has just completed a customer oriented survey. Data analysis is being completed to test those hypotheses that relevant to customer satisfaction. For example, in order to explore whether or not customer satisfaction is dependent on cost item 'maintaining E-service', let 'customer\_satisfaction' be an independent variable and 'maintaining\_E-service' a dependent variable, then test the effect of *customer satisfaction* on the *maintaining E-services* in individuals.

Through testing more hypotheses, findings will be presented into an integrated E-service factor relationship model (Figure 2 is a part of the model) which involves all the relationships among the four groups of constructs shown in FCBS research framework: *E-service functions, costs, benefits and customer satisfaction, with kinds of relationships: dependent, correlated and non-correlated.* The relationship model is intended as a mechanism for clearly identifying options, opportunities and their implementations for E-service development. The findings shown in the relationship model will have the potential to help companies to improve the competitiveness of companies engaging in E-services by reducing costs, increasing benefits and improving E-service quality. Based on the findings, the project will propose recommendations for designing, maintaining and improving E-service to take full advantages of Internet.

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## References

- [1] Amor, D. (1999), *The E-businesses (R) evolution: living and working in an interconnected world*, Hewlett-Packard professional books.
- [2] Byrne, B. (1998), *Structural equation modeling with LISREL, PRELIS, and SIMPLIS: Basic concepts, applications, and programming*, Lawrence Erlbaum Associates.
- [3] Casati, F. & Shan, M. (2001), Dynamic and adaptive composition of e-services, *Information Systems*, Vol. 26, pp 143-163.
- [4] Cho, S. (1999), Customer-focused internet commerce at Cisco systems, *IEEE Communications Magazine*, Vol. 37, No. 9, pp 61-63.
- [5] Drinjak, J., Altmann, G., & Joyce, P. (2001), Justifying investments in electronic commerce, *The Twelfth Australia conference on Information Systems*, Coffs Harbour, 4-7, December 2001.
- [6] EIU: The Economist Intelligence Unit, Available at web site: <http://www.ebusinessforum.com/> 20/12/2001
- [7] Giaglis, G. M., Paul, R. J. & Doukidis, G. I. (1999), Dynamic modelling to assess the business Value of electronic commerce, *International Journal of Electronic Commerce*, Vol. 3, No.3, pp 35-51.
- [8] Greenemeier, L. (2001), E-service slump claims more victims, *Information week*, 2001, Mar. 12.
- [9] Hahn, J. & Kauffman, R.J. (2001), Evaluating web site performance in internet-based selling from business value perspective, <http://misrc.umn.edu/wpaper/default.asp>.
- [10] Hahn, J. & Kauffman, R.J. (2002), Evaluating selling web site performance from a business value perspective, *Proceedings of international conference on e-Business*, May 23-26, 2002, Beijing, China.
- [11] Helander, M.G. & Khalid, H. M. (2000), Modelling the customer in electronic commerce, *Applied Ergonomics*, Vol. 31, No. 6. pp 609-619.
- [12] Kurniawan, S. H. (2000), Modelling online retailer customer preference and stickiness: A mediated structural equation model, *Fourth Pacific Asia Conference on Information Systems*, Hong Kong, 1-3 June 2000.
- [13] Lee, C., Seddon, P. & Corbitt, B. (1999), Evaluating business value of internet-based business-to-business electronic commerce, *10<sup>th</sup> Australia Conference on Information Systems*, pp 508-519.
- [14] Liu, C. & Arnett, K. P. (2000), Exploring the factors associated with web site success in the context of electronic commerce, *Information & Management*, Vol. 38, pp 23-33.
- [15] Lu, J. (2001a), Assessing web-based electronic commerce applications with customer satisfaction: An exploratory study, *International Telecommunication Society's Asia-Indian Ocean Regional Conference, Telecommunications and E-commerce*, Perth, 2-3 July 2001.
- [16] Lu, J. (2001b), Measuring cost/benefits of E-business applications and customer satisfaction, *2<sup>nd</sup> International We-b Conference*, Perth, 29-30 November 2001.
- [17] Lu, J., Tang S. & McCullough, G. (2001), An assessment for internet-based electronic commerce development in businesses of New Zealand, *Electronic Markets: International Journal of Electronic Commerce & Business Media* Vol. 11, no 2, pp 107-115.
- [18] Lu, J. & Zhang, G. (2002), Which factors are affecting E-service benefit --A research framework, *International Conference on E-business (ICEB2002)*, Beijing, 23-26 May 2002.
- [19] Marshall, J. (2001), E-service, *Financial Executive*, Vol. 17, No. 1.
- [20] Ng, H., Pan, Y. J. & Wilson, T. D. (1998), Business use of the world wide web: A report on further investigations, *International Journal of Management*, Vol. 18, No. 5, pp 291-314.
- [21] NOIE (The National Office for the Information Economy) (2000), E-commerce across Australia, *Commonwealth of Australia*.
- [22] NOIE (The National Office for the Information Economy) (2001), The current state of ply: Measuring Australia's participation in the information economy, *Commonwealth of Australia*.
- [23] Rehesaar, H. (2001), Promoting user satisfaction, *The Twelfth Australia conference on Information Systems*, Coffs Harbour, 4-7, December 2001.
- [24] Smith, A. G. (2001), Applying evaluation criteria to New Zealand government websites, *International Journal of Information Management*, Vol. 21, pp 137-149.
- [25] Tang, J. D., Shee, D. Y. & Tang, T. (2001), A conceptual model for interactive buyer-supplier relationship in electronic commerce, *International Journal of Information management*.
- [26] Terry, J. & Standing, C. (2001), User involvement in E-commerce systems development, *The Twelfth Australia conference on Information Systems*, Coffs Harbour, 4-7, December 2001.

## Internal Customer Service: The Potential for E-Service

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### Abstract

This empirically based paper is concerned with the application of the notion of internal customer service, purchasing and procurement, to e-services. It contends that much of the recent research into e-business, and e-service in particular, has taken a primarily external customer focus. Reports suggest that the greatest potential of e-business comes from applications within and between businesses. The findings are based on data collected in an extensive research programme from interviews, cases and focus groups in 97 organisations. It has shown that contrary to views of the traditional purchasing and procurement functions, e-service improved customer perceptions of service through faster and easier service with speedier resolution of problems, improved process reliability with reduced mean time between failures together with overall cost reductions.

### 1. E-Service and the External Customer

Recent e-service research has been primarily concerned with the provision and development of service between an organisation and its *external* customers. Voss [1] for example developed ten key steps in the development of an e-service strategy to help create outstanding web-based services. Mieczkowska and Barnes [2] investigated issues of customer participation in the delivery of library services. Sousa [3] whilst concerned with the quality of the customer's experience considered the issues for service design. Verma et al [4] investigated the value added features e-services need to provide to gain market share and profits. Zhu et al [5] developed a model linking consumer-perceived quality with e-service to the SERVQUAL dimensions. Walker et al [6] investigated the reasons why consumers accept or reject technology. Electronic customer relationship management (CRM) whilst recognising the potential for data mining, improved segmentation and one-to-one marketing appears to have been primarily concerned with managing the relationship and indeed the contact with customers [7] [8].

It is interesting to note that the manufacturing-based electronic commerce literature has been much more internally focused concerned with, in particular, the implications for process design [9] [10] [11] [12]. Even more interesting is the conclusion reached by such authors, summarised by Barnes et al [11] "e-commerce is tending to automate, rather than redesign existing

processes: e-commerce operations tend to be run as discrete processes, with little or no integration between traditional and e-commerce business processes and their respective information systems .... organisations often display confused and often contradictory motives for e-commerce; there is little measurement and evaluation of e-commerce performance". Despite the internal focus of much of this work the internal customer service perspective seems to be missing.

### 2. The Importance of an Internal Customer Perspective in E-Services

Although understanding the impact of e-service on the external customer is important and not in dispute, data from research organisations such as Forrester Research and Gartner, has demonstrated that the greatest potential from e-business will be in B2B applications both within (i.e. internal services) and outside the organisation.

Recognising the importance of internal services is not new. The importance of the internal customer has long been accepted as a key issue in operations design and improvement. "For an organisation to be truly effective, every single part of it, each department, each activity and each person and each level, must work properly together, because every person and every activity affects and in turn is affected by others" [13]. Central to this is the notion of the internal customer "every part of an organisation contributes to external customer satisfaction by satisfying its own internal customers" [14]. From a marketing perspective this internal customer notion is also well-accepted [15] and has led to the concept of internal marketing [16]. However the application of the notion of the internal customer to e-business, and e-service in particular, is relatively new.

The object of this paper is to evaluate an application of e-service to internal services in order to assess if such developments can not only improve the quality of service provided but also reduce the cost of doing business.

### 3. E-Procurement

E-procurement has been the subject of a great deal of research but again this has focused on the development of inter-organisational electronic networks. Malone, Yates and Benjamin [17] argued that the developing inter-organisational electronic networks would improve co-

ordination between firms to reduce the costs of searching for appropriate goods and services (they call these *electronic brokerage effects*). Consequently, they claimed that one of the major effects of inter-organisational networks would be a shift from hierarchical to market relationships. “Some of the initial providers of electronic markets have attempted ... to capture customers in a system biased towards a particular supplier. We believe that, in the long run, the significant additional benefits to buyers possible from the electronic brokerage effect will drive almost all electronic markets toward being unbiased channels for products from many suppliers” [17,p.492]. Brousseau [18] reviewed 26 inter-organisational networks, finding that most were used to reduce production or distribution costs and served to reinforce already existing hierarchical relationships among firms. Only in two, the petroleum business and textiles, was the use of inter-organisational networks associated with buyers gaining advantage by having more suppliers from which to choose. Evans and Wurster [19] claimed that the low infrastructure and transaction costs of Internet-based systems allow organisations to exploit the increased opportunities for complex information exchange with multiple partners, but also recognised the value to be gained through closer relationships between trading partners (‘affiliation’). Amit and Zott [20] likewise discussed the importance of close relationships (‘lock-in’) between trading partners as a key source of advantage to both buyer and seller, whilst Barratt and Rosdahl [21] claimed that ease of search and transparency acts as an advantage to the buyer but may be a disadvantage for the seller.

#### 4. E-Service – The Impact of E-Procurement

The procurement function of public and private sector organisations typically operates at the interface between the organisation’s operational processes and the external supplier marketplace. The function’s role is clearly a dichotomous one – it acts as both a customer and a supplier. Many elements of the procurement process are analogous to a typical marketing process: including - identification of (internal customer’s) needs, translation of those needs into specification, management of the delivery of goods and services to the internal customer and evaluation of the internal customers’ satisfaction. The other elements of the process involve communication with suppliers – requests for tenders, price negotiation, ordering receipt and invoicing. Electronic procurement systems mirror the procurement process through the provision of two distinct, but connected, infrastructures - internal processing (via, for example, corporate intranet) and external communication with the supply base (via, for example, Internet-based platforms) [22]. Each of these provides opportunities to enhance customer service – internally and externally.

Three service-related phenomena are of interest to our internally focused paper:

1. **Customer perceptions:** Internal customers perceive the quality of service offered by the traditional purchasing function to be poor. Consequently the function is held in low regard [23]
2. **Process compliance:** The traditional procurement process for indirect supplies for internal customer is characterised by low internal compliance [22]
3. **Cost reduction:** Cost of procurement is a key concern effected by trying to minimise transaction costs by limiting the number of suppliers [24] [25].

#### 5. Method

In this paper we report on the findings from our ongoing research into the nature and impact of electronic procurement (e-procurement) systems on internal customer service. This research programme has been concerned with building knowledge in e-procurement and has so far consisted of a series of interviews, cases and surveys conducted over the last two years with adopters and users of e-procurement systems. Ninety-seven organisations in total have been studied, including public sector bodies and a range of private sector organisations. All have participated in an extensive telephone survey, many have participated in focus group workshops and 16 have contributed to the development of more detailed case analyses.

In analysing internal e-service relationships we employed service quality criteria identified by Johnston [26] as the codes for labelling and presenting our data. These criteria are:

Attentiveness	Communication
Responsiveness	Competence
Care	Functionality
Availability	Commitment
Reliability	Access
Integrity	Flexibility
Friendliness	Security
Courtesy	

#### 6. Findings

In assessing the impact of e-procurement on internal customer satisfaction we investigated the impact of on-line requisitioning and ordering using on-line catalogues and procurement cards. We also examined the implications of the financial modules of e-procurement on improved budgetary control and management reporting (see table 1).

In this respect we found that the use of an accessible (i.e. available at the desktop) and centrally specified service process produced clear *operational* improvement in terms of process performance such as: speed of processing (measured from requisition to order acknowledgement); system reliability (measured in terms

**Table 1: Improvements from e-service**

<i>Criteria</i>	<i>Characteristics</i>	<i>Significance</i>
<b>On-Line</b> Responsiveness, Availability, Reliability, Flexibility, Functionality, Access	<b><i>(Decouples user-provider interactions)</i></b> Mean time between failure of system key requirement (infrastructure reliability). 300% increase in speed of response from request to order (process time) Increased range of goods and services available on-line Reconciliation of expense to budget (integration between systems) Price savings (better sourcing)	<ul style="list-style-type: none"> <li><input type="checkbox"/> Process design and reliability a critical element of the delivery of e-service.</li> <li><input type="checkbox"/> MTBF a vital area – this was found to vary between cases according to network reliability and 24/7 support.</li> <li><input type="checkbox"/> Speed of response is seen as key order winner – increasing compliance and thus reduces off-contract buying.</li> </ul>
<b>Helpline</b> Friendliness, Care, Courtesy, Flexibility, Attentiveness, Access	<b><i>(High contact)</i></b> Service interaction a key factor in satisfaction. Speed of resolution to queries and problems seen as important element of effective support. Customisation of support to deal with range of user knowledge and variety of system queries.	<ul style="list-style-type: none"> <li><input type="checkbox"/> Helpline staff capability, particularly the use of technically expert frontline help staff a significant contribution.</li> <li><input type="checkbox"/> Call-centre management a critical element of the delivery of e-service.</li> </ul>
<b>Expectations and Perceptions</b> Communication, Competence, Commitment	<b><i>(Explicit service process design)</i></b> Behavioural shift (changing practices) Cultural shift (changing perception) Technological focus –rather than business process change. Control – e-procurement allows ‘invisible control’	<ul style="list-style-type: none"> <li><input type="checkbox"/> Managing internal service relationships a key factor for effective e-procurement.</li> <li><input type="checkbox"/> Technology focus can improve compliance for technically capable staff, but acts as a barrier if not.</li> </ul>

of mean time between failure); greater range flexibility (larger catalogues). Additionally, users ability to improve budgetary information through on-line reconciliation and allocation of expenditure was seen as a significant benefit to their ability to control their own budgets whilst also reducing the burden on the Finance department. Finally, price improvements through consolidation of centralised purchases delivered increased budgetary efficiency – although in a number of cases this actually proved to be a disincentive! A fundamental concern here was that many managers are measured and evaluated according to the size of their budget – any significant reduction in purchase price leads to a reduction in the size of their budget. This was viewed as a real barrier to some of the fundamental changes needed to ensure compliance and buy-in with the systems.

Since, in many cases, user help was provided by a range of methods (including on-line, telephone and face-to-face) we have identified the characteristics and consequences of generic helpline support for the development and maintenance of internal service. The speed of resolution of queries was found to be a critical issue during e-procurement implementation and has a positive relationship to the extent of compliance by users. As the level of compliance is a primary performance measure of effective implementation, helpline design and delivery is critical to achieving high levels of compliance

and the consequent improved control over the procurement process. One of the most direct influences on speed of resolution was the use of expert frontline help staff. By deploying highly trained staff as the first point of contact a far larger proportion of queries are resolved through a single call (as there is less need for referral) than where junior staff were used as the initial contact point.

The third area of interest related to what was broadly described by respondents as ‘cultural shift’. An explicit focus on internal customer service, through mechanisms such as newsletters, intranet web sites and other internal marketing as well as cross departmental briefings and presentations, all highlight the value and contribution of effective service communication. In a number of our respondents the communication had concentrated almost exclusively on the technical characteristics of the systems and on user training. Almost paradoxically the response from such users was strong only where they were already technically competent (or ‘computer literate’). The perception in such organisations was that unless the training was well designed and part of a customer-focused service it acted as a disincentive to the user.

## 7. Conclusions and Implications for Internal E-Services

This paper has provided some evidence that there is a role for e-service, in particular e-procurement in helping improve internal customer service and reduce costs.

1. **Customer perceptions:** The application of e-service to internal purchasing and procurement improved customers perceptions of service - service was faster, easier with speedier problem resolution and control of budgets
2. **Process compliance:** The reliability of the process improved through reductions in MTBF together with high levels of compliance and control using help-line support.
3. **Cost reduction:** e-service applied to procurement enabled a restructuring of overall costs through the consolidation of centralised purchasing without the need to restrict the supplier base.

## References

- [1] Voss C., *Trusting the Internet: Developing an eService Strategy*, Institute of Customer Service, Colchester, 2000
- [2] Mieczkowska S., and Barnes D., "New economy new library: electronic commerce and customer participation in university library service processes", in Christiansen J., and Boer H., (eds), *Operations Management and the New Economy*, Copenhagen Business School and Aalborg University, Denmark, 2002, pp 933-941
- [3] Sousa R., "Quality in E-Services", in Christiansen J., and Boer H., (eds), *Operations Management and the New Economy*, Copenhagen Business School and Aalborg University, Denmark, 2002, pp 1391-1402
- [4] Verma R., Iqbal Z., and Plaschka G., "Understanding Value Drivers in e-Services", in the proceedings of the 7<sup>th</sup> International Research Seminar in Service Management, La Londe les Maures, France, 2002, pp 518-538
- [5] Zhu F.X., Wymer jr. W., Chen I., "IT-based services and service quality in consumer banking", *International Journal of Service Industry Management*, vol 13, no 1, 2002, pp 69-90
- [6] Walker RH., Craig-Lees M., Hecker R., and Francis H., "Technology-enabled service delivery: an investigation of the reasons affecting customer adoption and rejection", *International Journal of Service Industry Management*, vol 13, no 1, 2002, pp 91-106
- [7] Nyamp M., *The Customer Differential*, American Marketing Association, New York, 2001
- [8] Storbacka K. and Lehtinen J.R., *Customer Relationship Management*, McGraw-Hill, Singapore, 2001
- [9] Albores P., Ball P.D., and MacBryde J., "Assessing the impact of electronic commerce in business processes: a simulation approach", in Christiansen J., and Boer H., (eds), *Operations Management and the New Economy*, Copenhagen Business School and Aalborg University, Denmark, 2002, pp 15-26
- [10] Dennis S., King B., Hind M., and Robinson S., "Applications of business process simulation and lean techniques in British Telecommunications Plc", in Joines J.A., Barton R.R., Kang K., and Fishwick P.A., (eds) *Proceedings of the 2000 Winter Simulation Conference*, pp 2015-2021
- [11] Barnes D., Hinton M., and Mieczkowska S., "Managing Operations in the Internet era", in Christiansen J., and Boer H., (eds), *Operations Management and the New Economy*, Copenhagen Business School and Aalborg University, Denmark, 2002, pp 99- 109
- [12] Gunasekaran A., Marri H.B., McGaughey R.E., and Nebhwani M.D., "E-commerce and its impact on operations management", *International Journal of Production Economics*, vol 75, no 1-2, 2002, pp 185-197
- [13] Muhlemann A., Oakland J. and Lockyer K., *Production and Operations Management*, Pitman, 6th ed, London, 1992
- [14] Slack N., Chambers S., and Johnston R., *Operations Management*, 3rd edition, Prentice Hall, London, 2001
- [15] Berry L.L., and Parasuraman A., "Services Marketing Starts From Within", *Marketing Management*, Winter 1992, pp 25-34
- [16] Berry L.L., "The Employee as Customer", *The Journal of Retail Banking*, vol 3, no 1, 1981, pp 33-40
- [17] Malone T., Yates J., and Benjamin R., "Electronic markets and electronic hierarchies: effects of information technology on market structure and corporate strategies", *Communications of the ACM*, 30 (6), 484-497. 1987
- [18] Brousseau, E. "Information technologies and inter-firm relationships: The spread of inter-organizational telematics systems and its impact on economic structure", *International Telecommunications Society*, Venice, June. 1990.
- [19] Evans and Wurster, *Blown to Bits*, 2001
- [20] Amit R. and Zott C., "Value Creation in E-business", *Strategic Management Journal* 22(6/7). 2001
- [21] Barratt M. and Rosdahl K. 'Exploring business-to-business marketsites'. *European Journal of Purchasing and Supply Management* 8(2): 111-122. 2002
- [22] Croom, S. 'The Impact of Web-Based Procurement on the Management of Operating Resources Supply' *The Journal of Supply Chain Management*, Winter. Vol. 36; No. 1. pp 4-13 (10 pages). 2000.
- [24] Lamming RC. *Beyond Partnership. Strategies for Innovation and Lean Supply*. Prentice Hall. London 1993
- [25] Hines P., *Creating World Class Suppliers. Unlocking Mutual Competitive Advantage*, Pitman: London. 1994
- [26] Johnston R., "The Determinants of Service Quality: Satisfiers and dissatisfiers' *International Journal of Service Industry Management*' 6(5). Pp 53-71. 1995
- [23] Nolan A., "Purchasing's new power", *Director*, vol 52, no 7, 1999, pp 46-49.

# In-Depth Revealing Grid Based Web Service Provision Model: Grid Service Provision (GSP)

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## Abstract

Current development of network infrastructures is undergoing rapid transformation. With the emergence of the Open Grid Service Architecture and Globus Toolkit as incubators for evolving ASP business model to maintain profitability, this paper presents an in-depth analysis of the hypothetical Grid Service Provision (GSP) model by firstly giving an historical account of evolutionary factors in Internet architectures leading to Grid and P2P and secondly, investigating GSP model in the contexts of Service Level Agreements metrics and GSP implementation details. It is acknowledged by some experts that this hypothetical model is technologically feasible in reality.

## 1. Introduction

Application Service Provision (ASP) which is regarded as alternative and primary software application delivery model to Small or Medium Enterprises (SMEs) has been reaching maturity [1]. The ASP model, typically a 'one-to-many' model, often delivers web-enabled applications to SMEs using IP-based telecom infrastructure. Compared to the more numerous studies on the decision to outsource or not in the context of a client relationship [3] and ASPs marketing strategies, few studies have looked at the influence of new networking technology on the ASP

business model, and how this might optimize an ASP's Quality of Service (QoS). With the increasing migration towards the trend of interoperability and collaborative-work between individuals and corporations to conduct the electronic business (E-business) on Internet, a higher demand that shifting the internet service networks away from best-effort, vertical network architectures to a more intelligent and enhanced networking service to enable end-to-end service-aware network paradigm is claimed by both business practitioners and users [3]. With the

emergence of Web Service [4] and WSDL<sup>1</sup> which have come to be known as an interface and description language in which software operations are network-accessible through standardized XML messaging, the attractive features of Web Service are showing potentials for xSPs to broaden the scope of QoS they deliver to end-users and also increase the skill to serve the business computing market. Today's business computing pattern features a collaborative ecosystem of corporations and individuals that can exist in a holistic computing process. Since Web Service makes it reality that the software applications can be platform-independent and also execution-independent of the programming language [4] in which it is written, Web Service technology offers the business computing users an alternative way to receive the software application service not only from xSPs' server farm, but also from the peer users' computers. This significant technical improvement progress provides users with chances to obtain the high QoS from a bigger and broader dimension of networking and computing environment, including Peer-to-Peer (P2P) computing. Consequently, one curiosity for requiring a feasible and ideal networking infrastructure underpinning and optimizing Web Service to function is arising to both academic researchers and service provision business practitioners. The emerging Grid Computing technologies with its unbeatable advantages are now expected to meet this requirement.

## 2. Related Work

Service providers of all types (xSPs), including ASPs, must deal with many issues if they hope to become long-term survivors in this fast-changing ecosystem. xSPs need compelling services to sell – and rock-solid infrastructure platforms on which to host those services [7]. xSPs need to monitor and measure service use and

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<sup>1</sup> WSDL - Web Service Description Language.

the quality of the services (QoS) they deliver. Due to the fact that no single service provider can do all of this alone, xSPs need to form alliances, which usually include Independent Software Vendors (ISV), platform vendors, Internet Connection Vendors (ICV), and also infrastructure vendors. Each stakeholder plays a complementary role in delivering the service.

Focus of debates in prior research has been on the (re)allocation of the xSPs resources and also the alliance of the xSPs to offer the clients better QoS, as well as to enhance their competency to prevent the customers from turning to rival providers. Moreover, many academic researchers are now 'hyping' the development and deployment of the web service technology as the encouraging transition for ASPs; from web-accessible software-as-service to higher-level integrated collections of software operations that will finally operationalise successful ASP delivery for customers. Compared to pre-packaged applications, the unique aspects of web services can be summarized as:

- Web service-based applications are loosely coupled;
- Application component-oriented;
- Cross-technology implementations;
- Available to be used alone to carry out a complex aggregation or business transaction.

A leading IT consultancy, Ovum has released findings of its research on this latest development in computing and communications: [8,9]: "Within the next five years Web services will mean the death of the pre-packaged application, known to - and even occasionally loved by - users around the world today". However, all of these discussions are based on WWW protocols and IP-based telecom infrastructures. Hence, they miss the unprecedented advantages that Grid computing can bring to the IS world. In the Web Service era, old-fashioned ASP/xSPs software-as-service delivery pattern on the HTTP-IP based networking infrastructure is not likely to achieve interoperability due to the xSPs' intrinsic characteristic of "one-to-many" relationship between service providers and users.

## 2.1 JXTA vs. Microsoft.NET

To achieve the business process interoperability, P2P computing signifies a decentralized architecture [10]. The most mature application areas for P2P computing are file sharing and instant messaging in the users' space. P2P takes a class of advantage of resources available at the edges of the Internet including: Storage; Cycles; Content and Human presence. Web Services, on the other hand, is an attempt to take the Web model for publishing - loosely coupled components with a simple "request-and-response" model - and apply it to computing using XML messages instead of HTML documents [11]. Due to its insistence on well-defined

standards such as XML-RPC, SOAP<sup>2</sup>, WSDL and UDDI<sup>3</sup>, Web service applications are able to communicate between client and server, and different Web Services are also designed to work together, in order to achieve the fundamental goal of interoperability.

The stumbling block for current P2P computing is that two P2P applications using HTTP transport mechanisms are not guaranteed to communicate due to the little progress that has been made so far in adopting general standards. For example, two Napster users must install the same application so that they can share MP3 songs. Likewise, another typical example of P2P collaborative work groupware [12] (requests all the users to install a class of software to organize their activity) is Groove [13], made by Groove Networks. Groove allows co-workers to expose data directly to other users while they are working at their computers, and when they are off-line, the other user can continue working on the file that has been saved on the shared "workspace". Users can get resynchronised once they reconnect to the shared "workspace" again. Although Groove equips users with an impressive array of tools for getting group work done over the Internet, users still need to install this software to form a virtual workspace to achieve interoperability.

### 2.1.1 Microsoft.NET

Two leading P2P practitioners in business computing like Microsoft and SUN Microsystems are pioneers in exploiting the great potential for combining Web Service with P2P computing.

Microsoft HailStorm (which is now called Microsoft .NET My Services) announcement brings a light to the dawn of increasing the two areas of overlap. Microsoft plans to bring new convenience and richness to the lives of consumers by increasing the utility and value of devices, applications, and the Internet. Building upon the proven capabilities of Microsoft .NET Alerts and Microsoft .NET Passport. .NET My Services will allow businesses to build stronger customer relationships by improving web sites and web services, offering operational efficiencies that can cut costs and increase profits, and provide new business opportunities for the industry<sup>4</sup>. From a customer's perspective, .NET My

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<sup>2</sup> Simple Object Access Protocol - provides a means of messaging between a service provider and a service requestor.

<sup>3</sup> Universal Description, Discovery, and Integration.

<sup>4</sup> The .NET My Services platform is a collection of XML Web services that are invoked over the Internet by means of industry-standard protocols including SOAP, XML, and Universal Description, Discovery, and Integration (UDDI). The instant messaging system is undergoing changes so it can be used as a platform for Web services. The associated 'Passport' will provide identity services and Microsoft Messenger will offer presence management for networked applications, such as personal information storing, including contacts, e-mail,

Services ensures that the information is private, secure, and available. By default, personal information is only accessible to the user. Once information is placed in the .NET My Services “Digital Safe Deposit Box”, a user can control it with fine granularity; choose to share that information with friends, family, groups with which they have an association, or with businesses. In addition, from the business perspective, Microsoft .NET My Services makes Mobile E-commerce a reality in which users can sign up to receive alerts on any of a number of desktop or mobile devices, enabled by XML cross-platform transaction functionality.

So far, the overlap area in which P2P and Web Services seem to be converging is XML messaging. P2P technology still needs to focus on general standards on which to build the conversation. Moreover, P2P is a narrow scope technique term referring to locating files in small-world networks. Locating files in an environment with potentially hundreds of thousands of geographically distributed nodes is challenging because of scale and dynamism. In such an environment, the system has multiple sources of variation over time:

- Files are created and removed frequently;
- Nodes join and leave the system without a predictable pattern,
- A large number of components may aggregate into frequent group level changes.

Notwithstanding this added opportunity, P2P is still under development; the benefits of decentralization have been recognized.

Decentralization was an architectural principle of the Internet itself, but over a period of 10 years, the Internet has changed significantly. The concept of the ASP model as major software application delivery pattern has been widely accepted and this has caused a shift in thinking of the Web/Internet as becoming increasingly centralized. Paradoxically, this is just what the internet and computing tenets often try to reverse.

### 2.1.2 SUN JXTA

With respect to progress has been made so far in infrastructure, Sun Microsystems developed a set of protocols in their Project JXTA for ad hoc, pervasive, peer-to-peer computing [15]. Project JXTA was designed to standardize a common set of protocol needed to build peer-to-peer applications that enable peers to discover each other, self-organize into peer groups, advertise and discover network resources, communicate, and monitor one another.

Project JXTA significantly differentiates itself with .NET by a set of creative features [15] that are appealing academics’ interests:

- Achieved decentralization;

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calendar, profile, lists, electronic wallet, physical location, document stores, application settings, favourite Web sites, devices owned, and preferences for receiving alerts [14].

- Exploitation of increased bandwidth;
- Processing and storage available on devices connected at the edge of the Internet

Project JXTA presents a successful example of an optimization solution in the absence of general standards that early P2P computing might need to adopt. Decentralized computing systems constructed on JXTA architecture present the experience [15] of a community environment where members propagate and share information in a decentralized, self-organizing and open manner, as shown in Figure 1.

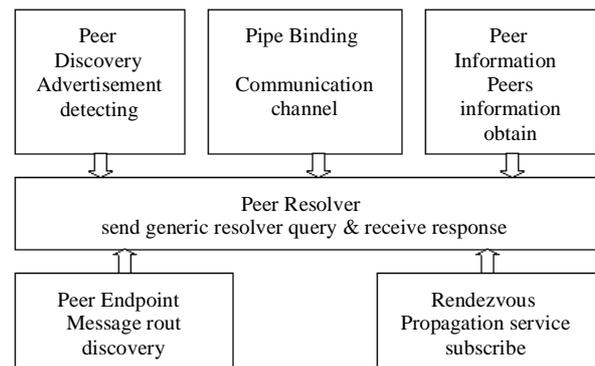


Figure 1. The Project JXTA Protocols

(Source: Project JXTA Virtual Network. Sun Microsystems. 2002)

JXTA protocols work together hierarchically by equipping Peer-to-Peer computing with generic infrastructure that is likely to be able to achieve the goal:

- Develop and deploy P2P services;
- Applications in a virtual self-adapting community;
- Enable a diversity of P2P application and services to be implemented.

### 2.2 Grid Computing and OGSA

Peer-to-Peer computing developments however try to build P2P applications and communications based on a standardized common set of protocols. The characteristic of P2P infrastructure (including all types of enablement) may intrinsically assign no dictating policies, nor dominant peers amongst the virtual community. P2P computing allows client computers to bypass traditional database stores and exchange data directly client-to-client, hence peer-to-peer. Nevertheless, P2P has a dark side [16]: P2P is considered by some to be a ‘socialist computing platform’ whose existence and survival relies largely on trust. The concerns that users can be trusted in P2P deployments and to securely transfer information are currently important questions asked by both academics and enterprises. Likewise, Peer-to-Peer virtual communities are based on decentralized organization

structures and without centralized monitoring could lead to networking-and-technology anarchism.

### 2.2.1 Grid Computing Origination

There is a bewildering debate concerning increasing and maximising computing efficiency by means of workflow decentralization, so that the computing pattern will comply with computing science principle: computing happens where the data is! But a certain degree of centralization is still inevitably necessary. However, this argument will fortunately not become a new fallacy at all. It depends on how we look at the definition of centralization. In today's e-business and e-science, we often need to integrate services across distributed, heterogeneous and dynamic communities formed from the disparate resources within a single enterprise and/or from external resource sharing and service provider relationships. This integration can be technically challenging because of the need to achieve various qualities of service (QoS) when running on top of different native platforms. Foster et al summarized that the ideal target environment for application developers should be:

- Homogeneous;
- Reliable;
- Secure;
- Centrally managed.

Business needs to deliver software applications and services to a vast customer base through distributed networks. There is also the requirement to integrate distributed resources to provide customers with higher Quality of Service. These requirements demand a large-scale, precise and advanced technical computing framework and this development now has led to the emergence of Grid technologies [17,18].

A Grid infrastructure is extremely intricate in terms of the scale and complexity of the services it must provide. The 'Grid Problem' or Grid challenge is defined as the flexible, secure, coordinated resource sharing among dynamic collections of individuals, institutions and resources. These collective organisations are referred to as 'Virtual Organisations (VOs) [19]. Despite their intricacy, Grids present many opportunities for applications in such areas as the World Wide Web, Enterprise Computing, Internet and Peer-to-Peer computing, Application Service Provision and other generic service provision schemas (xSP) [19]. Nevertheless, Grid computing is not simply a broader concept than that of Peer-to-Peer, there are fundamental differences in different contexts. Table 1 shows the Grid and P2P computing comparison and their primary diversity.

### 2.2.2 OGSA Architecture

With the infrastructure of P2P computing for building a virtual community, similarly with Grids, there are a set of infrastructure elements, which now are known as

Open Grid Service Architecture (OGSA) that is being used to construct virtual organizations.

OGSA as a holistic grid service architecture uses the Web Service Description Language (WSDL) to achieve self-describing, discoverable service and interoperable protocols, with extensions to support multiple coordinated interfaces and change management. In addition, OGSA uses the Globus Toolkit to define conventions and WSDL interfaces for a Grid service, which is a (potentially transient) service that can support reliable and secure invocation, lifetime management, notification, policy management, credential management, and virtualization [18]. As a result, OGSA provides a standards-based distributed service system that supports the creation of the sophisticated distributed services required in modern enterprises and inter-organizational computing environments.

Context	Grids	Peer-to-Peer
Enablement	<ul style="list-style-type: none"> <li>• Enable Communities to share resources (computer power, data, storage)</li> <li>• Enable new Applications by the coordinated use of geographically distributed resources</li> <li>• Enable controlled and coordinated sharing of resources among "virtual organisations"</li> </ul>	<ul style="list-style-type: none"> <li>• Computers (PCs) in a P2P network share resources directly (bypassing a central server)</li> </ul>
Infrastructure Type	<ul style="list-style-type: none"> <li>• Persistent infrastructure for Computing</li> <li>• The Internet as a Computing Platform</li> </ul>	<ul style="list-style-type: none"> <li>• Distributed Computing File sharing, Instant messaging, Enterprise Collaboration, People-to-People</li> </ul>
Original Motivation	<ul style="list-style-type: none"> <li>• High-end science and engineering</li> </ul>	<ul style="list-style-type: none"> <li>• Distributed Computation, Sharing, Business</li> </ul>

Table 1. Grids and Peer-to-Peer Comparison.

From the standardized common set of protocols prospective, the creation of large-scale infrastructure requires the definition and acceptance of standard protocols and services, just as the Internet Protocol (TCP-IP) which is at the heart of the Internet [20]. Thus far, no formal standards process has been developed for Grids, however, the Grid Forum [21] is working to create one. Nonetheless, currently there is a remarkable degree of consensus on core technologies. Essentially all major Grid projects are being built on protocols and services provided by the Globus Toolkit [22], which was developed by a group of scientists<sup>5</sup> in the United States and other institutions.

<sup>5</sup> Ian Foster's team at Argonne National Laboratory [29] (operated by the University of Chicago) in collaboration with Carl Kesselman's team at Information Sciences Institute, the University of Southern California.

### 3. New Generation Service Provision building on OGSA and Web Service

Taking advantages of both Grid and Web services technologies, the Open Grid Service Architecture (OGSA) defines mechanisms for creating, managing and exchanging information among entities which is emerging as new generation services delivery pattern – Grid Service. Briefly summarized, a Grid Service is a Web service that conforms to a set of conventions (interfaces and behaviours) that define how a client interacts with a Grid service [23]. The Web Service Definition Language (WSDL) has common application interfaces, and conventions (behaviours that include: dynamic service creation, interface address naming and discovery, controlled fault resilient, notification, manageability, and upgradeability of the distributed long-lived state). This and the OGSA infrastructure together define a Grid Service.

#### 3.1 The Enabling Environment to Implement Grid Service within a VO

The collective organisations in a VO typically maintain not merely a static set of persistent services that handle complex activity requests from clients<sup>6</sup>, they often need to instantiate new transient service instances dynamically, which then handle the management and interactions associated with the state of particular requested activities [18]. The OGSA conventions, protocols, and infrastructures underlie the Grid web service in service implementation. The WSDL application interfaces enable the specific execution in the hosting environments or with more sophistication the containers such as J2EE, IBM Websphere, Microsoft.NET and Sun One. The containers here refer to an implementation-programming model, programming language, development tools, and debugging tools.

#### 3.2 Hypothetical GSP Model

Work [5] on the hypothetical Grid Service Provision (GSP) model so far that provides quality of service in Web Service Application delivery with Open Grid Service Architecture (OGSA) support is still in an embryonic phase. Current work on GSP can be divided into two stages: GSP definition and futuristic scenario simulating analysis in the context of Service Level Agreement (SLA) metrics.

The ASPs/xSPs applications and services provision model can embrace a new lifecycle. The key to reaching this new horizon is to move to a common program-to-program interaction model. New applications are being developed with programming models (such as the Enterprise Java Beans component model [24]) that

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<sup>6</sup> Clients here refer to service requestors, in the context of “resource-sharing relationship” in a VO.

insulate the application from the underlying computing platform and support portable deployment across multiple platforms. The Open Grid Service Architecture provides a broad set of protocols as low-level infrastructure to communicate and manage the pervasive computational edge resource of a VO. Meanwhile, the development of programming models which comply with Web Service Description Language (WSDL) and Extensible Markup Language (XML) specifications are building blocks to enable the ASP software application delivery model to evolve. As a result, unlike the scientific Grid service architecture such as SETI@home [26] or Grids in Aerospace industry [25], developing and deploying Grids in business computing are pledged to harness new opportunities and market niches in the Grid era. Figure 2 is a hypothetical Grid Service Provision model and is shown at the end of this paper.

From the physical fabric point of view, OGSA is an extension of HTTP-IP based networking. After applying Grid computing to the current networking physical infrastructure using OGSA mechanisms to build a VO, the decentralization and distribution of software, hardware, and human resources would make it essential that the desired quality of service (QoS) are achieved. This type of ubiquity in computing and service patterns will largely change the traditional way that enterprises do business, especially e-Business. The impact of Grid computing, whether measured in terms of common security semantics, distributed workflow and resource management performance, coordinated fail-over, problem determination services, or other metrics – on resource assembled dynamically from enterprise systems, service provider systems, and customer systems [18] – will all alter our perception and understanding of computing.

### 4. Analysis and Implication

In old-fashioned ASP/xSP models, customers receive the software application through web, and host their business data on the xSP’s server farm. Customers are confined to the relationship with the ASP/xSP on a long-term or short-term subscription basis and this depends on whether they decide to rent or lease the service [27]. Despite Service Level Agreements (SLAs), customers have to accept the “as is” quality of services provided by vendors with very little customizability. Furthermore, there are also several problems with the services: based around imperfect connectivity, ASPs’ remote management and resource management.

Grid technologies support the sharing and coordinated use of diverse resources in dynamic VOs, from geographically and organizationally distributed components to highly integrated creations to achieve the desired QoS [19]. Enterprises are also now expanding the scope and scale of their enterprise resource planning (ERP) projects as they try to provide better integration with customer relationship management (CRM), integrated supply chain management and existing systems. Grid Service Provision may help to release this

significant pressure on the enterprise IT infrastructure as well as to achieve the following:

- Supports dynamic resources allocation in accordance with the service-level-agreement (SLA) policies, efficient sharing and reuse of IT infrastructure at high utilization levels, and distributed security from edge of network to application and data servers.
- Deliver consistent response times and high level of availability, which in turn drives a need for end-to-end performance monitoring and real-time reconfiguration.
- In addition, assure the security, auditability, SLA and complex transaction processing flows of multi-organizational supply chain management, B2B integration in cross-enterprise business-to-business collaboration.

#### 4.1 Analysis of Grid Service Provision (GSP) model

Peer-to-Peer computing evangelises the current business computing pattern into interoperability paradigm, built on Grid computing and OGSA architecture. With the development of software engineering, the traditional software-as-service can be integrated with web pages and delivered via internet. .NET and J2EE as popular implementation-programming model, programming language, development and debugging tools that can help realize the Web Service which can be simply understood as “functioning-web-pages”. With this functionality, web service can be simply and easily delivered by xSPs and received by users without pre-installed software-running supporting systems. From the users’ prospective, Web Service largely reduces the cost of IT investment and the complexity of maintenance – the commonly and broadly used web browser can carry out this implementation of Web Service.

The functionality-encapsulated web service contributes feasibility to developing and deploying interactive and cooperative interoperability in today’s collaborative electronic business ecosystems. Business and individual users can receive software applications (web service) from service providers, as well as from peer users alternatively. SMEs, as major marketing target for xSPs, are given flexibility to acquire web service from multi resources: xSPs’ server farm and/or Peers users.

Due to the fact that web service can be hosted at various places, users do not need to shuffle raw data around a network to wait for processing by a centralised mainstream computer at an ASP’s server farm, and furthermore, ASPs do not need to bear the overload work for user’s computing requests - there is a large waste of resources, considering bandwidth, user idle time; data secure transferring issues, etc.

With the emergence of distributed computing, in which Grid computing has marked an important new phase; the ASP model can evolve by using the advanced networking architecture to deliver software applications. The convergence of web services and Grid computing

technologies is expected as an approach to solving and resolving current ASP delivery problems. Moreover, such new technologies may bring a revolution to the current software application delivery pattern, and this could have a pervasive impact on the IS world, like IP based WWW (World Wide Web) did in the last two decades of the 20<sup>th</sup> century.

As a result, academic researchers [5] are attempting to evolve the old fashioned ASP business model into Grid Service Provision (GSP) model by combining and converging Web Service technology and OGSA architecture to achieve the fundamental goal of interoperability.

#### 4.2 Inside GSP Model

GSP is not only an xSP technical framework, it is also likely going to be spoiled by business practitioners as a good business model that begins with an insight into human motivations and ends in a rich stream of profits [28].

When ASP evolves into GSP, users (SMEs) are regarded as VO members, who can inherit all VO’s features: flexible, secure, coordinated resource sharing among dynamic collections of individuals, institutions and resources. Once users sign in VO to start each service session/transaction, at the same time, GSP begin to monitor and measure the quality of service using Java-based intelligent agents [29] to ensure end-to-end QoS specifications and service price negotiations in such an environment. Java-based SLA/Pricing Agents are used to process user’s service request including identity verification, customised SLA specifications, and commit the service to be delivered to the requestor (user). Open Grid Service Architecture/Grid Engine/Container are used as application implementation platform and service interpreter/search/delivery engine to communicate both users and (Grid) Service Providers to ensure the service quality and SLA fulfilment.

(Grid) Service Providers are responsible for managing security issues, user information, resource discovery and advertising, data storage, etc. When a service request is accepted, GSP will search the resources throughout the whole VO and GSP itself in order to respond to this request. This responsive process is hidden and transparent from a user’s point of view because the resources can be stored on GSP’s server and also peer-users’ computers. This responsiveness mechanism guarantees quick and efficient service response to the request. One of significant attributes of GSP model is the ability to create added-value that benefits peer users: members in a VO, who have spare resources such as storage space, can share the extra computational ability with GSP to help host web services and deliver to the other peer users. Both spare resource provider members and GSP benefit the profit from this sharing.

Compared to old fashioned ASP, GSP model presents many opportunities to improve the level of QoS and increase the profit margin, as shown in Table 2.

## 5. Conclusion and Discussion

Traditional ASPs have focused on economy-of-scale in the past a few years, and some successful players have achieved this goal. In today's Web service and Grid environments, vendors are being given the opportunity to embrace achievement of both economy-of-scale and skill. Current trend of Electronic Commerce (E-Commerce) is to accelerate the shift of power toward the consumer (Adrian J. Slywotzky). Some advantages of Grid-enabled P2P networking will allow SMEs to reduce fees,

operational complexity, and increase interoperability. Grid computing and OGSA as originated for solving the scientific computing problems are now showing the potential to serve the business computing market. However, GSP is a hypothetical model which is lack of empirical evidence and study. It is consistent with technology development in reality. Hence, this model still needs to be tested and implemented by both academic researchers and business practitioners for further development.

Context	GSP	ASP(old-fashioned )
Service Delivery Pattern	Peer-to-Peer (Many-to-Many)	One-to-Many
Infrastructure Type	Extended HTTP-IP Networking	HTTP-IP, WWW Networking
Motivation	<ul style="list-style-type: none"> <li>• Better QoS</li> <li>• Customised service for user</li> </ul>	<ul style="list-style-type: none"> <li>• 'as is' products</li> <li>• Pre-packaged service</li> </ul>
Relationship with user	<ul style="list-style-type: none"> <li>• Peer-to-Peer relationship</li> <li>• VO members</li> </ul>	Server/Client
Interoperability	High	Low
Service Charge Method	per Session/Transaction	User's Subscription
User's accessibility	Easy access (Join the VO)	Need technical support
Networking Control/Monitoring	Difficult	Easy
User's Cost	Reduced(Low)	High
Providers' Investment	Reduced cost by resource sharing	Incremental investment
Organisation Architecture	Decentralised	Centralised

Table 2. GSP and old-fashioned ASP comparison.

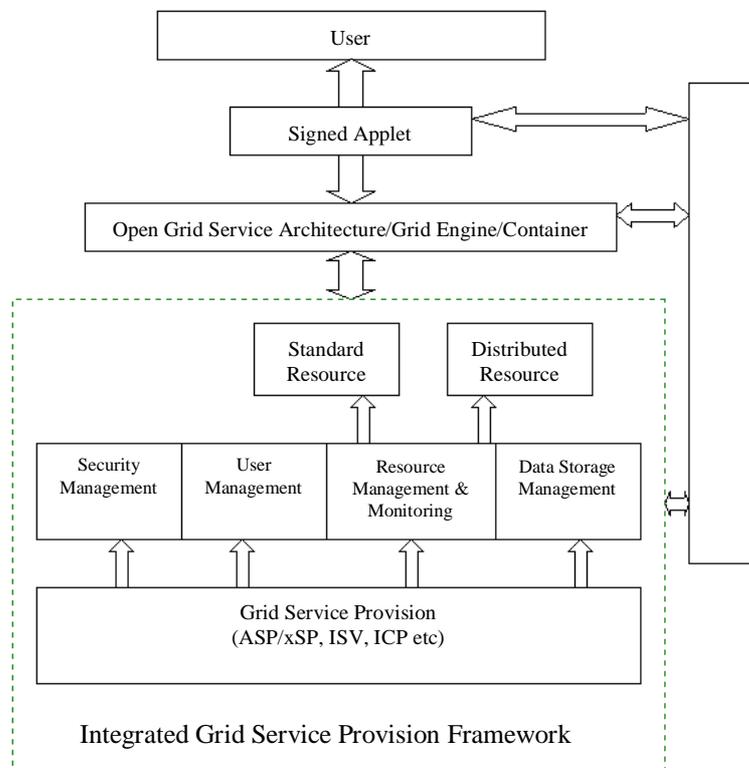


Figure 2. Hypothetical Grid Service Provision model

## References

- [1] Wainwright, P. "Web Service Infrastructure", A White Paper. 2002.
- [2] Yao, Y., Murphy, L. 2002. "Client Relationship Development for Application Service Provider: A research Model". 3<sup>rd</sup> HICSS Proceedings.
- [3] Vicente, J., et al. "Programming Quality of Service in Modern Internet Service Platforms", [www.cs.columbia.edu/~lerner/CS6998-03/FinalProjectReports/DiffServ%20--%20Programming%20QoS.pdf](http://www.cs.columbia.edu/~lerner/CS6998-03/FinalProjectReports/DiffServ%20--%20Programming%20QoS.pdf)
- [4] Kreger, H. 2001. "Web Service Conceptual Architecture". IBM Software Group.
- [5] Huinan Xu, Phil Seltikas. "Evolving the ASP Business Model: Web Service Provision in the Grid Era", Proceedings (In Press) 2<sup>nd</sup> IEEE P2P Computing International Conference. Sweden. 2002.
- [6] Neureiter, G., et al. "The BRAIN Quality of Service Architecture for Adaptable Services with Mobility Support". [www.dit.upm.es/~ist-brain/publications/BRAIN\\_QoS.pdf](http://www.dit.upm.es/~ist-brain/publications/BRAIN_QoS.pdf)
- [7] McCabe, L., Davis, D. 2002. "Middleware and Web Service for xSPs: Why now, why IBM?" Summit Strategies
- [8] Wainwright, P. 2002. "Web services spell death for packaged applications". LooselyCoupled.com
- [9] Hallett, T. 2002. "Web services: Applications will never be the same again". [www.silicon.com](http://www.silicon.com).
- [10] Dougherty, D. 2001 "P2P Networking Overview – The Emergent P2P Platform of Presence, Identity, and Edge Resources". 2001, O'Reilly&Associates, Inc.
- [11] Shirky, C. 2000. "What is P2P and What is Not?" [www.openp2p.com](http://www.openp2p.com)
- [12] Webopedia. Groupware definition. [www.webopedia.com/TERM/g/groupware.html](http://www.webopedia.com/TERM/g/groupware.html)
- [13] GooveNetworks. [www.groove.net](http://www.groove.net)
- [14] Microsoft Cooperation. Microsoft .NET My Service. [www.microsoft.com/my services/services/overview.asp](http://www.microsoft.com/my services/services/overview.asp)
- [15] Traversat, B. et al. 2002. "Project JXTA Virtual Network". Sun Microsystems.
- [16] Beach, G. 2000. "CIO.com Opinion: Peer Review". [www.cio.com](http://www.cio.com)
- [17] Foster, I., Kesselman, C., Lee, C., Lindell, R., Nahrstedt, K. and Roy, A., "A Distributed Resource Management Architecture that Supports Advance Reservations and Co-Allocation". In Proc. International Workshop on Quality of Service, (1999), 27-36
- [18] Foster, I. et al, "The Physiology of the Grid – An Open Grid Services Architecture for Distributed Systems Integration". 2002. [www.globus.org](http://www.globus.org)
- [19] Ian Foster, Carl Kesselman, Steven Tuecke. "The Anatomy of the Grid: Enabling Scalable Virtual Organisations". The International Journal of High Performance Computing Applications, 15(3):200-222, Fall 2001.
- [20] Foster, I. 2000. "Internet Computing and the Emerging Grid". Nature Web Matters. [www.nature.com/nature/webmatters/grid/grid.html](http://www.nature.com/nature/webmatters/grid/grid.html)
- [21] GRIDFORUM. [www.gridforum.org](http://www.gridforum.org)
- [22] GLOBUS. [www.globus.org/toolkit](http://www.globus.org/toolkit)
- [23] Steven Tuecke, Karl Czajkowski, Ian Foster, Jeffrey Fray, Steve Graham, Carl Kesselman – "Grid Services Specification – Draft Version" – [globus.org](http://globus.org) – February 2002.
- [24] Thomas, A. "Enterprise Java Beans Technology: Server Component Model for the Java Platform". 1998, [http://java.sun.com/products/ejb/white\\_paper.html](http://java.sun.com/products/ejb/white_paper.html).
- [25] Alleon, Guillaume. "Grid computing experiences in the aerospace industry". EADS Corporate Research Centre. 2001
- [26] SETI@home Project. <http://setiathome.ssl.berkeley.edu>
- [27] Wainwright, P. "To Lease or to Rent, that is the Question". ASPnews.com article. 1999
- [28] Magretta, J. "Why Business Models Matter". Harvard Business School Publishing Corporation. 2002
- [29] David Chieng, Alan Marshall, Ivan Ho, Gerard Parr. "Agent-Enhanced Dynamic Service Level Agreement in Future Network Environments". E.S. Al-Shaer and G. Pacifici (Eds.): MMNS2001, LNCS 2216, pp. 299-312, 2001. ©Springer-Verlag Berlin Heidelberg 2001. [www.mnlab.cs.depaul.edu/mmns2001/proceeding/22160299.pdf](http://www.mnlab.cs.depaul.edu/mmns2001/proceeding/22160299.pdf)

# Planning and Deployment of Collaborative Commerce: A Conceptual Framework

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## Abstract

This article proposes a conceptual framework for planning and deploying collaborative-commerce (c-commerce). The framework consists of two dimensions: the type of inter-organizational relationships and the level of engagement that involved organizations want to achieve. The combination of these two dimensions generates nine categories of collaborative-commerce. Each category designates an opportunity for c-commerce initiates. The article characterizes each category with two concepts: focus and linkage interface. Focus means the interest or benefits that one type of c-commerce is expected to achieve. Linkage interface refers to major elements that facilitate the type of c-commerce to move forward and keep the involved parties as a whole. Examples are identified to illustrate the nature of each category.

Practitioners can use the framework as a roadmap to assess the commitment and trust level and subsequently, determine the type of c-commerce. Researchers can use the framework to identify issues specific to each category and specify features of enterprise application pertaining to each category. Three main directions are also identified for future research to further understand the phenomenon of c-commerce.

## 1. Introduction

As the competition of business environment becomes more intense and information technologies (IT) become more sophisticated than ever, firms are rapidly adopting innovative use of IT to outreaching customers, building partnerships, and creating new forms of organizations. Ramifications of this trend include the creation of various new forms of commerce, such as electronic-commerce, electronic-business, and mobile commerce. According to a recent report [2], the next stage of growth in the enterprise application software business is collaborative commerce (c-commerce). The report estimated that the size of the c-commerce market would grow from \$5.8 billion in 1999 to \$36.5 billion in 2004 (estimated by AMR and IDC). Several successful cases of c-commerce have been reported in various industries, such as the aviation and aeronautics, automobile manufacturing, and telecommunication. For example, Boeing improved its production productivity from 228 airplanes per year in 1992 to 620 expected in 2002 by using collaborative e-marketplace [5].

As many firms start adopting c-commerce, issues surrounding c-commerce have caught researchers' attention. For example, Welty and Becerra-Fernandez (2001) investigated the issue of managing trust and commitment in collaborative relationships. Kumar [13] delineated the features of information and communication technologies for supporting c-commerce.

Although sporadic research about c-commerce has been reported, an examination of extant research shows that there is a lack of systematic research into the phenomenon of c-commerce. The purpose of this article is to propose a conceptual framework for planning and deploying c-commerce at the firm and industry level. We believe that, in the early stage of c-commerce, such a conceptual framework is crucial for understanding the phenomenon of c-commerce. With the conceptual framework, researchers could synthesize previous studies and identify issues specific to different types of c-commerce. The framework can also be used by practitioners as a roadmap to take into account relevant issues when they consider investing in c-commerce.

## 2. Literature Review

C-commerce is claimed as the next generation of enterprise software applications, yet the practice of collaboration is not new. In fact, collaboration is part of human life. By working together, people could overcome challenges imposed by the nature and survived from acts of the nature. As a result, while research in c-commerce in the field of IT is still in its infancy, the topic of collaboration has caught researchers' attention in a variety of disciplines. For example, researchers in the field of social services have investigated how business, government, and stakeholders form collaborative alliance to generate constructive solutions to social problems [8]. In the field of marketing, researchers examined the factors that affect the development of collaborative relationship between buyers and sellers [24] and how to develop and sustain collaborative supply chain relationships [23].

Meantime, only limited research in c-commerce has been conducted in the field of IT. Those existing studies focused on two themes: (1) reporting successful anecdotes and (2) IT infrastructures for building c-commerce. Examples of successful stories [5] [12] are available in companies in various industries: those are Boeing Co., Lockheed Martin Aeronautics, Co., General

Motors Corp., Juniper Networks Inc., and Toshiba Canada Office Corp.

The emphasis of IT infrastructure prevails in the extant literature of c-commerce. For example, Bellini, Gravitt and Diana [2] define the c-commerce market by three categories of enterprise application software: supplier relationship management, knowledge management, and product lifecycle management. They assert that the demand for software in these three categories will grow when companies look for ways to close the loop of product development value chain. They report that the collaborative capabilities of those applications usually leverage the Internet, rather than an enterprise proprietary nationwide network. Also, the collaborative capabilities require an environment to “facilitate inter-company business processes and community management with integration to extend the enterprise in a unique and ubiquitous way” [2, p. 7].

Fou [7] claims that the ultimate aim of c-commerce is to maximize return on intellectual capital investment, improve business agility, and provide better quality of customer experience. In order to achieve the objective, Fou believes that the next stage of c-commerce must be built on web services, and he proposes a Web-service-based collaborative architecture that consists of four tiers: c-commerce vendors, web services, business rule engine, and multi-dimensional c-commerce enterprise web portal. Furthermore, Fou classifies the evolution of c-commerce into three stages: (1) web-enabled single-dimensional and single-process c-commerce, (2) B2B exchanges-based, single-dimensional and multiple-process c-commerce, and (3) web service-based, multiple-dimensional and multiple-process c-commerce.

In contrast, Derome [4] downplays the importance of state-of-the-art technologies in developing collaborative relationship. For example, according to him, e-mail is a c-commerce tool, as are Electronic Data Interchange (EDI) and Extensible Markup Language (XML). Thus, Derome [4] believes that c-commerce capabilities should be depicted from a functional standpoint. He defines c-commerce as a three-layer architecture: Free-form collaborative services, process collaboration layer, and the structured data exchange category. The IT environment, duration of collaboration, and goal of collaboration vary from category to category. Although Derome suggests a variety of technologies (so-called collaboration over Internet Protocol, CoIP) for each of the three categories, he emphasizes the importance of deriving value propositions from the development of a collaborative relationship. However, the value propositions he proposes are mainly from transaction-focused applications.

Li and Williams [16] examined six case studies and found that companies that had established a successful cooperative relationship at the transactional level by creating interfirm network (via proprietary or open systems) tended to develop new and collaborative partnership at the strategic level. They observed similar evidence in the sectors of retailing and manufacturing. Their studies show that further developed collaborative

relationship could occur in the existing transactional application or a new application devoted to the new partnership. However, they found that different types of applications were more often developed on different IT infrastructures.

In addition to studies regarding successful c-commerce cases and IT infrastructures for c-commerce, several other studies have been reported. For example, Alexander [1] reported benefits of c-commerce and barriers of deploying c-commerce from a practitioner’s point of view. Mulani and Matchette [18] propose a total lifecycle collaboration framework that ties the mutual strategic objectives of two companies to actual inter-company execution. The connection between strategic objectives and actual executions is realized by developing critical decisions and metrics for various types of collaboration in different stages of the lifecycle of new product development. Ramachandran and Tiwari [20] studied the air cargo industry and reported that collaborative supply chain providing economic global air cargo services should be based on a business model that consists of three layers: connectivity layer, knowledge layer, and functionality layer.

As shown by the above review, research studies of c-commerce are scarce. Reporting successful cases and IT infrastructure for c-commerce dominate the extant research. Although the selection of appropriate IT infrastructures is critical for developing successful c-commerce, yet it is not sufficient. This is because collaboration is not a purely technological issue. As indicated in several studies, successful c-commerce depends on trust and commitment among partners, as well as individual partner’s capability of providing required services. We believe that a framework for planning and deploying c-commerce that considers those aspects should be developed.

### **3. Framework for Planning and Deploying C-Commerce**

#### **3.1 Rationale**

Before we delve into the detail of a framework that we propose, it seems appropriate to address the rationale for those factors we consider in the framework. Himmelman defines organizational collaboration as “a process in which organizations exchange information, alter activities, share resources and enhance each other’s capacity for mutual benefit and a common purpose by sharing risks, responsibilities and rewards” [9, p. 28]. This definition suggests that the development of collaborative relationship has a profound impact on the involving parties. Thus, firms that plan to invest resources into a collaborative relationship should consider c-commerce as gradually progressive applications of enterprise-level IT that attain and support the collaborative relationship. They should evaluate their relationships with business partners and the level of engagement that they would like to be involved. While inter-organizational relationship depends on objective factors, such as the industry sector, and the nature of the

business, the level of engagement is determined by trust and commitment held by the firm on its business partners.

Trust and commitment are generally considered as premises for establishing a collaborative relationship [23]. Trust could be broadly defined as the belief that others will act or react in a predictable way [17]. Trust is important for the creation of partnership because it could reduce uncertainty and provide certain extent of assurance for managers' decisions. Consequently, it might determine the commitment we assert on a partner relationship. Trust and commitment are a relative concept. Just like relationship between individuals, relationships between companies begin, grow and develop [11]. The level of trust and commitment grows following the development process of relationship between two parties. The trust level built from an acquaintance is presumably lower than that acquired from a friendship. The level of trust and commitment will determine the level of involvement that one party is willing to engage with another party and as a result, it will indirectly determine the level of e-commerce that one party would like to establish.

In practice, previous studies [16] also show that the first step of developing interfirm collaboration seems to be developing a routine application so that trust and commitment could be nurtured. Consequently, a framework for planning and deploying e-commerce should take into account the variation of trust and commitment between organizations and provide sufficient granularity of choices so that firms could determine the type of e-commerce to create.

### 3.2 Dimensions of the Framework

Our conceptual framework for planning and deploying e-commerce is based on two factors: (1) type of inter-organizational relationship (IOR) and (2) the level of engagement determined by trust and commitment. There are several classifications of IOR available in literature of organization sciences. We believe the classification proposed by Whetten [28] is sufficient to serve the purpose of our study. Whetten classified IOR into four categories: dyadic linkages, organization sets, action sets and network.

Dyadic linkage is the simplest form of interaction between organizations, and this linkage occurs "when two organizations find it mutually beneficial to collaborate in accomplishing a common goal" [28, p. 5]. A typical example of this type of IOR is a joint venture by two organizations. Another example of this linkage can be simple coordination that one organization performs some part of production activities while the other performs the rest to achieve higher efficiency.

Organization sets are the total sum of inter-organizational linkages between a focal organization and its trading partners [28]. There is only one focal organization that mainly manages the interactions and conflicts. In this IOR, relations among non-focal organizations are minimal and thus can be ignored. A typical example is a big manufacturer that coordinates its product design effort with several small parts suppliers.

Another example is a manufacturer whose parts or work-in-process are supplied by multiple suppliers.

Action sets are coalitions of organizations working together to accomplish a specific purpose [28]. Action sets are networked interacting group of organizations. Unlike organization sets, there is no one clear focal point in action sets; however, it is still possible that one, two or more organizations play roles of leaders in this type of IOR. An example of this type of IOR is coalition of small banks to provide shared ATMs to their customers. It should be noted that this is one type of networked IOR, which will be described below, since there are direct interactions among partners without going through a focal organization.

The last form of IOR is a business network. A business network is defined as "the structure of interdependent relationships between the activities of a given firm and those of other firms in its competitive environment that influence each other's strategies" [10, p. 60]. A business network, thus, usually represents all interactions that occur among trading partners [28]. A typical example is the supply chain of manufacturers, distributors, wholesalers, and customer-facing firms at the retail level for any commercial products [13]. As mentioned before, action sets are a special type of network IOR, and thus we treat both action sets and business network as "network" type of IOR in our framework.

The three stages of organizational evolution in using IT [22] are employed to differentiate the level of engagement. Those three are: Automate, Informate, and Transform. "Automation" means using IT to reduce the cost of production. Here production has a broader meaning, including the production of physical goods, information processing, and any other forms of human activities. Typically, traditional, manual and paper-based operations are computerized to reduce manpower necessary to carry out the operations.

A company in the "informate" stage is to empower managers with IT. The empowerment is mainly achieved by providing managers with information generated by IT tools. Meanwhile, a company may create economic value of information that is the by-product of automation. Typical examples include using decision support systems to "informate" managers to make better decisions or using data mining techniques to identify patterns and trends of customer purchasing behavior from transaction data for better planning. A company at this stage needs workers who have ability to interpret and analyze information that generated from basic transactions.

A company in the "transform" stage might have successfully gone through the first two stages and been ready to capture opportunities presented by the environment by transforming its organization and/or by changing the rules of the games of the market. Companies in this stage are characterized by strong IT leadership, vision, and a sustained process of organization empowerment. In other words, a company in this stage is committed to align business and IT strategies well and exploit IT-enabled opportunities.

### 3.3 The Framework

Using these two dimensions, we propose a conceptual of framework as shown in Table 1. We will discuss each category in terms of concept, focus, and linkage interface. Focus means the interest or benefits that one type of c-commerce is expected to achieve. Linkage interface refers to major elements that facilitate the type of c-commerce to move forward and keep the involved parties as a whole.

#### 3.3.1 Automatic Dyadic Relationship

The main concept of automatic dyadic relationship is to use IT to automate existing interactions between two companies in order to improve the efficiency and other benefits of the interaction. The main focus of this c-commerce application is to improve the efficiency of business transactions, such as reduction in time, reduction in labor, and increase in transaction accuracy. The

linkage interface in this type is structured data format, which may be based on proprietary or open standards. Because the linkage interface is structured data format, this type of automatic relationship seldom causes changes in internal processes of the firms, although it may change job descriptions and requirements for skills. This is the most basic or simplest form of c-commerce. As a matter of fact, this type of relationship dated back to 1970s when companies started to use electronic data interchange (EDI) to automate highly structured transactions. Wal-Mart's continuous replenishment system (CRS) is an example of automated dyadic relationship [14] (It should be noted that even though a retailer like Wal-Mart apparently has many suppliers, since those suppliers are relatively independent of one another, the relationship between Wal-Mart and each of its suppliers could be considered as dyadic relationship.) The continuous replenishment system enables Wal-Mart to reduce its inventory cost to a minimum level with a stockless

**Table 1. A conceptual framework for planning and deploying c-commerce**

Types of Inter-Organizational Relationship					
		Dyadic	Organization sets	Networks	
	Automatic Dyadic Relationship	Concept	Automate existing interactions between two companies	Automate interactions among partners via a focal company	Automate linkages among members of the business network
		Focus	Efficiency	Efficiency of individual relationships and a group seen by a focal partner and timely action	Efficiency of flows and effectiveness of managing uncertainty
		Linkage interface	Structured Data	Structured data/information	Data/information/algorithms
	Informative Relationship	Concept	Informing partners with IT products	Informate and strengthen critical relationship	Informate partners and strengthen all partners as a group or redesign the business network.
		Focus	Effectiveness	Efficiently and effectively identify and strengthen critical relationships	Efficiency, effectiveness, and competitive success
		Linkage interface	Information/know-how	Knowledge about its business, partners, and products	Information/knowledge, experience, and insight.
	Virtual Organization	Concept	Transform relationship b/w partners	Transform relationships and create miniature community around a focal partner or function as a virtual organization	Change the scope, boundary, and/or structure of the business network
		Focus	Efficiency, effectiveness, new value, & new opportunity	Efficiency, effectiveness, values, and new opportunity	Collaborative advantage/competitive advantage, new economic opportunity, efficiency of the whole industry
		Linkage interface	Knowledge/division of labor & rewards	Complementary partnership/compatibility between skills/knowledge/division of labor/vision of a focal partner	Value, vision, and potential external threats.

business model. This allows Wal-Mart to implement its low cost strategy and thus, to create competitive advantages over its rivals.

In the past, because most of EDI systems were based on proprietary technologies, investment in EDI systems reflected a high level of engagement companies committed to this type of relationship. However, as open standards (such as TCP/IP, XML) become popular, companies could adopt a technology based on those standards to automate a dyadic relationship. Because of lower switching cost with technologies based on open standards, the company could relatively easily switch from a relationship to another and, consequently, the engagement level will not be as strong as it used to be.

### **3.3.2 Informed Dyadic Relationship**

The main concept of informed dyadic relationship is that one company uses information generated from its applications of IT to inform its partner so that its partner will make necessary arrangement to respond to anticipated future events. The focus of the relationship is to effectively respond to changes in the environment. Information that could be helpful for responding to plausible events in the future is the interface that holds involved firms together. The sharing and use of the information might cause minor changes in internal operations in one party. In an even closer relationship, one party of a dyadic relationship might even share the know-how of forecasting and/or its historical data set.

An example of informed dyadic relationship is the continuous replenishment program (CRP) in Procter & Gamble, Co. The CRP has similar functions as those of CRS in Wal-Mart. The CRP is capable of analyzing changes in customer buying habits and, subsequently, Procter & Gamble adjusts its product schedules to both and actual purchases and anticipated demand. Furthermore, Procter & Gamble kept its retail customers informed by sharing the analysis result to improve supply chain efficiency and effectively respond to changes in the needs of customers.

The engagement level of this type is high because companies must share their proprietary information as well as how to use the information. Sharing this type of information not only reflects the engagement level that one party is committed to the relationship, but also paves a foundation for further enhancement of confidence and trust. As the nature and sharing of information is the linkage interface, the type of technologies becomes less an issue.

### **3.3.3 Transformed Dyadic Relationship**

The main concept of transformed dyadic relationship is that companies use IT to transform its relationship with its partners. The focus of transformed dyadic relationship is creating new value to existing market or capturing new opportunities, while it may include improvement in efficiency and/or effectiveness. The linkage interface is knowledge. Examples of knowledge include an understanding about the business that one firm is in and/or knowledge of division of labor when a new

opportunity opens. The firm and its partner will be able to divide the work and fully take advantages of their strengths. Another scenario is that a firm changes the structure of its relationships with partners and invite them work together. For example, a personal computer maker has an OEM company. In the past, the PC maker sells products (computers) to its customers via transportation service that it arranged. With the assistance from IT, the PC maker may change the structure in terms of division of labor by providing information about its customers to its OEM and the OEM is in charge of the delivery of products. The level of trust and commitment between the PC maker and its OEM is stronger than that between them in informed/automated dyadic relationship because in the present case, the PC maker firm will need to provide specific information about its customers and know-how of customer service and delivery to its OEM.

The engagement level of this type is very high because two companies must be willing to share responsibility and risk involved in the transformation of their relationship. The transformation of their relationship may require them to align their business strategies and IT strategies for common goals. Typically, if and after going through the automated and informed stages together, both companies might possess well-compatible IT infrastructure and are well ready for transformed dyadic relationship. The adoption of complicated, customized, enterprise-wide applications can be planned.

### **3.3.4 Automatic Organization Set**

The main concept of automatic organization set is that the focal firm uses IT to automate its interaction with partners. An example of automatic organization set is that a builder (or a construction company) who deals with several contractors in the construction industry may use IT to coordinate its interactions with contractors. In this case, after being commissioned to construct a building, the focal firm (i.e., the builder) might need to consult the architect for any doubt in the blueprint, to solicit constructors with different skills and techniques, and to make a plan to accomplish the project on time under budget. The main focus of the focal firm (i.e., the builder) is to maximize efficiency of its interactions with individual contractors as well as the efficiency of the group as a whole. In order to maximize the efficiency of the group as a whole, the builder could employ coordination technologies (e.g., groupware) to coordinate tasks performed by different contractors, to monitor the progress of tasks, and to keep contractors informed. Another example of automatic organization set is that a company may implement an electronic bidding system, which selects the best bidder following predefined criteria from a pool of suppliers.

This type of e-commerce focuses on efficiency of each relationship and the overall efficiency seen by the focal organization. The focus of automatic organization set is to efficiently exchange data among partners and take actions efficiently and effectively. The linkage interface is data and/or information about business transactions.

In this type, more partners are involved than the dyadic IOR and thus managing IT is more complicated. However, since there is a clear focal firm in this relationship, the means of data/information exchange is usually selected by the focal firm and partners follow the rules and protocols selected. The engagement level of this type is not high. Thus, industry standard or open standard should be used to avoid unnecessary switching costs on partners.

### 3.3.5 Informed Organization Set

The main concept of informed organization set is that the focal firm uses information generated from its application of IT and know-how's to enhance and strengthen its critical relationships with partners in its organization set. As Kanter [11] indicates, "Successful partnerships manage the relationship, not just the deal." [11, p. 96]. Thus, the focus of informed organization set is to effectively identify and manage relationships with those partners that are critical to the success of the firm. The linkage interface of informed organization set is to disseminate knowledge about the business, its partnership, products and/or its customers that is critical for the focal firm to identify and strengthen critical relationship with its partners. An example of informed organization set is the development of a Collaborative Planning, Forecasting, and Replenishment (CRFR) system in Procter & Gamble, Co. Based on inputs from its partnerships with retail customers, Procter & Gamble, Co. created an instrument called CPFR Capability Assessment for the baseline evaluation of the partnership's four core CPFR processes in eight key elements. The CPFR Capability Assessment is used to assess the strength and weakness of the partnership and actions needed to improve the development process of CPFR [26]. There are two purposes of developing a CPFR system: (1) providing inputs to further fine tune the CPFR Capability Assessment; and (2) improving inventory and reducing out-of-stocks through the supply chain from the manufacturing plants to customers' distribution centers to customers' retail store shelves to consumer homes.

A focal firm's main concern in this type is to handle conflicting interests of partners, enhancing the effectiveness of individual relationship and the overall effectiveness of the group simultaneously. Reasoning of its decision making must be shared with the partners, each of which compromises its own short-term interest, if necessary, for a long-term prosperity.

### 3.3.6 Transformed Organization Set

The main concept of transformed organization set is that the focal firm uses IT to transform its relationships with its partners, or enable itself function as a virtual organization. A focal firm needs to find critical complementary partners and divide the work so that a group can work toward the shared value and exploit an opportunity. The focus is to respond efficiently and effectively to the need of customers and to add value to the whole organization set and to capture economic

opportunity as a group. One possible scenario of transformed organization set is that with the accumulation of experience in using IT to automate and informate its linkages, the focal firm might gradually outsource its activities in design, production, and delivery to its partners and eventually becomes a virtual enterprise. In this case, the linkage interface includes knowledge about its products, customers, and the business that the focal firm is in, as well as guiding goals, strategies and values established by the focal firm. Even more important linkage interface is the knowledge about how to manage a virtual enterprise, how to make and execute plan, and how to coordinate independent activities in the virtual environment. For a focal firm to share those with its partners openly, a group can form a community around a focal firm. Thus IT applied in this relationship must be able to support planning and execution of a plan, as well as sharing information and exchanging transactional data. An example of transformed organization set is the case of Lockheed Martin Aeronautics Co. [12]. Lockheed used Net-collaboration technology to bring more than 80 suppliers that scattered in 187 locations to design and build components of a new family of supersonic stealth fighter planes for the Department of Defense. The Net-collaboration technology employed allowed Lockheed and its partners to keep all parts in sync by sharing designs, tracking the exchange of documents, and monitoring the progress of the project. While the impact of using this type of technology is at operational level in this case, in the long term, it may change the role of Lockheed because Lockheed will be able to tap the best talent, employ new business processes, and redefine roles of partners.

The above descriptions about automatic, informed, and transformed organization set highlight an important point: new and usually "soft" management skills and techniques are progressively more important when a company moves from automatic stage to transformation stage. As a result, how to overcome challenges imposed by a new environment that the firm is in becomes an important issue.

### 3.3.7 Automatic Business Network

The main concept of automatic business network is that all group partners use IT to automate existing linkages among partners. In order to make the business network work efficiently as a whole unit, involved companies usually need to exchange transaction data with its partners without a focal firm. Participating partners must share common goals and understand their roles in a network so a group can achieve maximum efficiency. This feature differentiates this relationship from the automatic organization set and from automatic dyadic relationships. The major objective is to make necessary adjustments in participating firms' internal operations so that the business network, as a unit, becomes able to move goods, information, and payment as smooth as possible. Efficiency in terms of flows and effectiveness in terms of the management of demand uncertainty is the focus of this relationship. The linkage interface of this

relationship is data and algorithms that could smooth the ripple effect generated from disturbances that may occur in one node in the network. Technologies often named “advanced planning systems” (APS) provide techniques, such as forecasting, time series analysis and linear programming, to analyze and optimize the flows of the network [13]. Those applications work best in a relatively stable environment because in such an environment, the structure of the business network will be stable enough to be modeled and optimized [13].

Although a leading firm (“lord of the chain” in Kumar’s word [13]) or a coordinator might appear in a business network in the long term, there is generally no dominating firm in the network. The commitment level, compared to other types of business network, is relatively low; however, the investment in those model-based technologies could be significant. Furthermore, sharing and assuming responsibility and risk in the network is critical for the whole network to function as a whole. As a result, the commitment level might be higher than automatic dyadic relationship.

### 3.3.8 Informed Business Network

Informed business network means that firms in a business network use IT to create values for themselves and partners in the same network by informing each other or redesigning the business network as a knowledge network [25]. Although information derived from historical data might be critical for informing partners to make necessary adjustments so that the flows of payment, goods, and information can move smoothly, the major drive of informed business network might be from experiences in the field, insight for the business, and intuitive judgments [13]. As a result, although data mining and optimization techniques might still be employed to manage demand uncertainty, experiences, insight, and expertise from different companies might be used to create “collective wisdom” to grasp the market opportunity. This scenario is particularly plausible when the business network faces the crisis of survival. The example of battle between the supply chain of buggies, buggy whips, stables and roadside carriage-hostelries against automobile described by Kumar [13] well illustrates the scenario. In this scenario, because the competitive success of a firm is no longer dependent on the firm’s effort, companies in the same business network will be more willing to share risk and obligations by informing its partners and being informed by its partners. The focus of this type of relationship would be efficiency, effectiveness, and competitive success of the business network. The interface linkage of informed business network will be information, knowledge, experiences, and insight.

### 3.3.9 Transformed Business Network

The notion of transformed business network is that the structure, scope, or boundary of a business network is changed with the introduction of IT into the network. Transformation may occur in the form of redefining the scope of the business network [25], creating an IT-

enabled value-net [3], or organizing as an E-Hub in an industry [19]. The scope of the business network could be redefined with new products, new markets, and/or new partners that are brought about by IT. Developing an IT-enabled value-net is intended to create collaborative advantage as well as competitive advantage [21]. The creation of an E-Hub might improve the efficiency of transactions for the whole industry, provide a forum in which industry-wide issues can be addressed and expertise and knowledge can be shared. Those purposes are all concerned with the development of the industry. Therefore, the focus of transformed business network is to create collaborative advantage, capture new economic opportunity, identify potential threats, and/or foster the growth of the industry by exploiting the capability of information technology as the network. The linkage interface of transformed business network is value, vision, and external threats.

An example of transformed business network is the transformation in the tax return preparation network [10]. The transformation of the tax return preparation is characterized by the expansion of the network, addition of new players, changes in roles of existing players and re-structure of the network [12].

## 4. Research Agenda

There are many issues that need to be addressed before we can truly understand c-commerce. In this section, we make an attempt to identifying several issues that we believe deserve researchers’ attention in the near future.

1. Conceptualization of coordination mechanisms in c-commerce: The process of c-commerce involves communication, cooperation, and coordination among partners. Various IT infrastructures proposed by extant research in c-commerce as well as advanced information technology, such as enterprise systems, might have sufficiently paved a foundation for serving the purposes of communication and cooperation. In order to depict the complete picture of c-commerce, conceptualization of coordination mechanisms in c-commerce is crucial. Answers to the following questions are critical to understand the phenomena of c-commerce: What coordination mechanisms are available? How do those firms coordinate their activities? On what ground do they choose one coordination mechanism over another? How does IT support selected coordination mechanisms? What c-commerce applications are best suited to support a particular coordination mechanism?
2. Evolution of c-commerce process: The creation and sustain of c-commerce involves tremendous investment in resources and commitment. The relationship among partners is usually not temporary. Our position is that those partners that progressively go through the automated, informed, and transformed stages over time will have greater success possibility, because mutual trust and commitment would be gradually built up in each stage and because partners could gradually cultivate

skills and techniques for managing their partnership. In this case, what enables and/or inhibits the transition and how an IT-enabled partnership evolves from one stage to another is an important topic to study. Meanwhile, we believe that other factors might offer opportunity for companies to engage in one particular type of collaboration rather than starting their relationship with automated relationship. As a result, what causes the evolution of intra-stage process and how the intra-stage process evolves is also essential for understanding c-commerce. Both inter-stage or intra-stage evolution can be examined by investigating into changes in properties of links (such as strength of the link and symmetry), roles participating firms play, position participating firms occupy, and properties of the network (such as connectedness, density, and reachability) [6].

3. Typology of collaborative network: Although it is claimed that the basic architecture of collaborative networks would be in the form of hub and spoke [19], we believe that the form of hub and spoke will not completely take the place of peer-to-peer communication. We further assert that although the form of hub and spoke is a preferable architecture of collaborative network at the firm or industry level, specific topology varies depending on the nature of projects, groups, and tasks. Also, the topology may vary depending on the stage of the life cycle of a project.

## 5. Summary

C-commerce creates a new form of commerce. Extant literature has focused on the issues of IT infrastructure and benefits. In this article, we proposed a conceptual framework for planning and deploying c-commerce at the firm or industry level based on two dimensions: the evolution of organizational computing capability and commitment, and the type of inter-organizational relationship. This framework allows researchers to classifying commercial applications of computer and communication technologies for c-commerce. It can be also used to identify issues specific to each type of c-commerce, and help practitioners to examine their standing in terms of planning and deploying c-commerce. Moreover, in the early stage of the development of c-commerce, we also identified several key issues that we believe need to be addressed to understand c-commerce better.

## References

- [1] Alexander, Steve (2000). Collaborative Commerce. *Computerworld*.
- [2] Bellini, Heather; Gravitt, J. P., and Diana, Dino (2001). The Birth of Collaborative Commerce. Salomon Smith Barney
- [3] Brandsnburger, Adam M. & Nalebuff, Barry J. (1996) *Co-opetition*. New York, NY: Currency Doublday.
- [4] Derome, Jon (2000). C-Commerce: Collaborative Commerce as the Ultimate Business Model. *BtoB Commerce & Application Report of The Yankee Group*, 5: 18, pp. 1 – 15.
- [5] Fingar, Peter (2001). Don't Just Transact – Collaborate. *CIO Magazine*. [http://www.cio.com/archive/060101/insights\\_content.html?printerson=yes](http://www.cio.com/archive/060101/insights_content.html?printerson=yes).
- [6] Fulk, Janet, & Boyd, Brian (1991). Emerging Theories of Communication in Organizations. *Journal of Management*, 17:2, pp. 407 – 446.
- [7] Fou, John. (2001). Web Services and Collaborative Commerce: Collaborate or Die. <http://www.webservicesarchitect.com/content/articles/fou01print.asp>.
- [8] Gray, Barbara (1996). Cross-Sectoral Partners: Collaborative Alliances among Business, Government, and Communities. In Chris Humham (ed.) *Creating Collaborative Advantage*. Sage Publication.
- [9] Himmelman, Arthur Turovh (1996). On the Theory and Practice of Transformational Collaboration: From Social Service to Social Justice. In Chris Humham (ed.) *Creating Collaborative Advantage*. Sage Publication.
- [10] Kambil, Ajit & Short, James E. (1994). Electronic Integration and Business Network Redesign: A Roles-Linkage Perspective. *Journal of Management Information Systems*, 10:4, pp. 59-83
- [11] Kanter, Rosabeth Moss. (1994). Collaborative Advantage: The Art of Alliances. *Harvard Business Review*, pp. 96-108
- [12] Keenan, Faith & Ante, Spencer E. (2002) The New Teamwork, *Businessweek*, [http://www.businessweek.com/magazine/content/02\\_07/b3770602.htm](http://www.businessweek.com/magazine/content/02_07/b3770602.htm)
- [13] Kumar, Kuldeep (2001). Technology for Supporting Supply Chain Management, *Communications of the ACM*, 44:6, pp. 58-61.
- [14] Laudon, Kenneth C. & Laudon, Jane P. (2001). *Essentials of Management Information Systems*, 4<sup>th</sup> Edition. Upper Saddle River, NJ: Prentice-Hall.
- [15] Laudon, Kenneth C. & Laudon, Jane P. (1999). Procter & Gamble: Finding the Right Business Model, in Laudon & Laudon, *Essentials of Management Information Systems* (pp. 66 – 67), 3<sup>d</sup> Edition, Upper Saddle River, NJ: Prentice-Hall.
- [16] Li, Feng, and Williams, Howard. (1999). Interfirm Collaboration Through Interfirm Networks. *Information Systems Journal*, 9, pp. 103 - 115
- [17] Luhmann, Niklas (1982). *Trust and Power*, John Wiley & Sons.
- [18] Mulani, Narendra P. & Matchette, John B. (2002). Lifecycle Collaboration: Lining Strategy and Execution to Sustain Superior Performance. in *Achieving Supply Chain Excellence through Technology* (pp. 206 – 208), sponsored by Accenture.
- [19] Phillips, Charles & Meeker, Mary. (2000). *The B2B Internet Report: Collaborative Commerce*. Morgan Stanley Dean Witter.
- [20] Ramachandran, Girish and Tiwari, Sanjay (2001). Challenges in the Air Cargo Supply Chain. *Communication of the ACM*, 44:6, pp. 80 – 82.
- [21] Rotemberg, Julio J. & Saloner, Garth (1991). Interfirm Competition and Collaboration, in Scott Morton, Michael S. (ed.). *The Corporation of the 1990s: Information Technology and Organizational Transformation*. New York: Oxford University Press.
- [22] Scott Morton, Michael S. (ed.) (1991). *The Corporation of the 1990s: Information Technology and Organizational Transformation*. New York: Oxford University Press.
- [23] Spekman, Robert E., Kamauff, John W., Jr. & Myhr, Niklas. (1998). An Empirical Investigation Into Supply Chain Management: A Perspective on Partnership. *International*

*Journal of Physical Distribution & Logistics Management*, 28:8, pp. 630 – 650.

[24] Sriram, Ven, Krapfel, Robert, and Spekman, Robert (1992). Antecedents to Buyer-Seller Collaboration: An Analysis From the Buyer's Perspective. *Journal of Business Research*, 25, pp. 303 – 320.

[25] Venkatraman, N. (1991). IT -Induced Business Reconfiguration, in Scott Morton, Michael S. (ed.), *The Corporation of the 1990s: Information Technology and Organizational Transformation*. New York: Oxford University Press.

[26] Voluntary Interindustry Commerce Standards Association (1999). Procter & Gamble, J&J, Target, Wal\*Mart, Sainsbury, and Tesco. In VICSA (1999), *Roadmap to CPFR: The Case Studies*. <http://www.cpfr.org/>

[27] Welty, Bill and Becerra-Fernandez, Irma (2001). Managing Trust and Commitment in Collaborative Supply Chain Relationships. *Communications of the ACM*, 44:6, pp. 67 – 73.

[28] Whetten, David A. (1981). Interorganizational Relations: A Review of the Field. *Journal of Higher Education*, 52:1, pp. 1 – 28.

# Reciprocal Effect of Team Commitment and Media Richness in eCollaboration: A Conceptual Model

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## Abstract

One of the major areas of E-Business applications is the sourcing of expert human resources globally with the help of virtual teams operating in various parts of the world. Major corporations are increasingly using eCollaboration technologies to make the functioning of these teams economical and effective. The tasks performed by these teams can vary from software design and development to providing back office services like call center support, technical support, transcription services etc. Additionally, after 9/11 corporations have embarked on major initiatives to implement eCollaboration technologies at the global level to help reduce travel.

Extensive work has been done to study the decision-making performance of face-to-face and virtual teams. However, previous studies have found conflicting results regarding the impact of media richness on decision-making performances of teams. This paper posits the significant role of media type on the communication richness when team members have low commitment to the collaborative team projects. A conceptual model that depicts the influence of media type on satisfaction, team conflict, social influence, and supportiveness that influences the team commitment has been developed. The influence of team commitment on communication richness is also examined. A controlled lab experiment is designed to test the research model.

## 1. Introduction

Team or group work is widely practiced in an organization to accomplish various tasks. With the advent of Internet technology organizations are increasingly using, virtual teams, whose members need not be present at the same location or at the same time [3] [19]. Researchers have investigated issues related to the virtual team practices [34] and the factors that influence virtual team performance [20]. One of the key factors contributing to team performance is effective communication [8], which is the focus of this study.

Virtual teams by definition do not have the luxury of a face-to-face meeting, but require the use of communication technology or “new media” as a medium to coordinate the work and share/exchange information among their members [20]. According to media richness

theory [8], “new media” should be used appropriately by matching characteristics related to media richness with a task’s requirements. However, communication effectiveness is affected not only by the match between media and task, but also by other factors, such as willingness and capability of the participants to adapt and use new media [25] [27] and social influence [39].

Using the Hermeneutic Interpretation approach to examine the actual exchange of e-mail messages among a group of managers, Lee [27] found that in addition to other factors, communication effectiveness requires the willingness and capabilities of members, and support from their organizations. Similarly, Kock [25] studied the use of computer-mediated meetings in a small group and found that “lean media” like e-mail (according to the classification of media richness theory) can be used as effectively as “rich media” like face-to-face for tasks that require high richness, if members using lean media are motivated enough. These findings are parallel to the organization literature on the affect of team commitment on team performance.

The studies of team commitment in organization literatures have addressed both the linkage between team commitment and performance [14] and the antecedents like perceived task interdependence, inter sender conflict, and satisfaction with co-workers. The antecedents are related to the level of team commitment [2]. Studies of organization communication and communication technology, consequently, have focused on the impact of communication medium, and other factors- mentioned earlier, on the team performance. However, none of these studies has specifically explored the possibility of media richness influencing the levels of team commitment.

The Social Influence Model can be used to explain the choice and use of media [39]. Similarly, based on team commitment literature, we argue that an individual using the same media can have either rich communication or lean communication with other members depending on the level of commitment to their team. We, thus, assert that team commitment influences the richness outcome of the media use. The purpose of this study is to determine the communication effectiveness (rich communication) in lean media usage under different levels of team commitment and to examine the effect of media characteristics on the level of team commitment. Thus, we posit that team commitment and media usage is not a one-way relationship. Extending upon the previous study

of Bishop and Scott [2] and on media richness and social presence theories [8], we argue that team commitment is not static and can also be influenced by the ability of medium to transmit multiple cues, immediacy of feedback, language variety, and the personal focus of the medium.

## 2. Theories and Model Development

### 2.1 Goal Commitment

One of the plausible explanations of why some people perform better than others when they all have equal abilities is their motivation to work harder [30]. According to goal setting theory, different goal levels motivate people to behave differently that results in performance differences. Researchers have shown evidence of a significant positive relationship between goal difficulty (high goals) and performance [29] [31] [41]. However, the goal difficulty does not have an effect on performance without commitment [17] [28] [42] [46]. Locke and colleagues considered commitment as an important factor in goal setting theory. Goal commitment can be defined as the resistance to change a goal over time [28] or the determination to try for a goal and the persistence to attain the goal over time [18] [32]. Locke [28] suggested that commitment influences how people expense their cognitive/physical effort to achieve a goal and hypothesize commitment to moderate or strengthen the relationship between goal and performance. Lock et al [32] suggested that the difficulty of the goal affects goal commitment. The moderating effect of goal commitment was also found to be stronger when a difficult goal is assigned [24]. However, prior study by Donovan and Radosevich [11] found that the moderating role of goal commitment on the goal difficulty-performance relationship accounted for less than 3% of the variance in task performance. This small effect might have been the result of the use of easy tasks for difficult goals in the study. The results of Martin and Manning [33] study suggest that commitment is important only when a difficult goal and a difficult task are used.

The commitment to accomplish a goal is classified on two dimensions - the expectancy and the attractiveness [17] [31]. Variables that affect both of these dimensions of goal commitment are: authority, peers/supervisors influence, supportiveness, monetary incentive, feedback, expectancy, self-efficacy, individuals' need for achievement, and past success.

Hollenbeck and Klein [17] classified the above variables into situation factors and personal factors affecting both attractiveness and expectancy of goal attainment. They suggested that the situation factors affecting attractiveness of goal attainment would be *publicness, volition, explicitness, reward structure, and competition*. Publicness refers to the awareness of others about one's goal. They argued that it is difficult to abandon publicly known goals because such behavior appears unattractive to other people. In a team context where all members know their team goal, members of a

team are unlikely be happy with a member who abandons a team goal.

Volition is defined as the individual's free time and energy to engage in a behavior. Low volition implies that people will easily abandon a difficult goal that requires more time and energy than they are willing to give. In an environment where people are involved in more than one team projects or have many responsibilities, time and energy become scarce resources and are not enough to accomplish all goals; thus, people may choose to accomplish some of their personal and team goals and abandon or change the level of remaining goals. In other words, goals that require less energy and time are more attractive than goals that require more resources.

The reward structure also influences the attractiveness of the goals. People prefer goals that have higher rewards than the goals that have low potential rewards. Therefore, high reward goals can be more attractive even though they require lot of energy and time. Unclear description of the goal or vague goals can lead people to believe that the goal is attractive, however, vague goals are not as effective in generating high performance [28]. Competition with other groups or team members, which creates a pressure or desire to accomplish a goal, is another important factor that influences the attractiveness of a goal.

Hollenbeck and Klein [17] also proposed several personal factors that would affect the attractiveness of goal attainment. For example, they argued that high *Need for achievement* personality was related to the commitment to difficult goals. Their arguments are based on the findings of a study [5] that people with high need for achievement set more difficult goals than people with a low need for achievement. Other personality variables that are relevant to goal commitment are *endurance* and *type A personality*. People with high endurance are willing to work longer hours, and do not give up quickly on a problem; thus they are unlikely to abandon difficult goals. Similarly, people with a type A personality, being aggressive and competitive, setting high standards, and putting themselves under time pressure, are more likely to set more difficult goals and put more effort to accomplish those goals.

Situation factors that would affect the expectancy of goal commitment are social influence, task complexity, performance constraint, and supervisor supportiveness [17]. Social influence with respect to others' performance, others' goals, and others' goal commitment, has shown a strong impact on goal commitment [17]. They suggested that individuals are unlikely to maintain their goal commitment when the majority of team members appeared to either abandon their goals or lower their goal level. An individuals' commitment level would be higher when team members have the similar goal level.

Martin and Manning [33] manipulated the level of normative information on, how others have performed (others did well/ others did poorly). They found that there was no significant difference in the performance of high and low goal commitment subjects when they were told

that others did not perform well. On the other hand, there was a significant difference in performance when subjects were assigned with different level of goal difficulty and were told that others performed well. The findings suggest the moderating effect of goal commitment on the relationship between the task performance and the normative information. However, the study did not examine whether there is an effect of normative information on goal commitment.

Additionally, Martin and Manning [33] examined the relationship among goal levels, performance, and goal commitment. They found that people with a low goal commitment could perform as well as people with a high goal commitment when easy tasks were used. However, when difficult tasks were assigned, the performance of people with high goal commitment was significantly better than the performance of people with a low goal commitment. These findings indicate that low goal commitment does not mean that people would attempt to fail or not accomplish the goal [33]. However, for people with low goal commitment assignment of difficult tasks may lead to frustration and high-level of anxiety, which may result in the goal abandonment.

Hollenbeck and Klein [17] identified high self-efficacy, past success experience, high self-esteems, and locus of control as personal factors affecting the expectancy of goal commitment. Their literature reviews (c.f. [15] [16] [29] [45]) indirectly supported the propositions of the relationship between the personality variables and goal commitment. Klein et al [24] found a correlation (0.38) between supervisor supportiveness and goal commitment.

Locke et al [30] asserted that goal commitment directly influences the performance of the team members. The strength of this relationship depends on the amount of variance in the goal commitment. Internal factors, external factors, and interactive factors that determine the variance of the goal commitment were identified. Internal factors include the expectancy of success and self-efficacy. External factors include legitimate authority, trust in authority, peer (group) influence, values, incentive, and rewards. Interactive factors include the participation of individuals in setting up their goal and competition.

Studies show that an authority's instruction need not always be obeyed [1]. In this case, the goal assigned should be legitimate (such as possible to be accomplished or reasonable). Legitimate authority and trust in the authority influences individuals to commit to the assigned goal. Social pressures or peer influence has a positive effect on commitment [12]. According to expectancy theory, the value of the outcomes and the estimated probability of effort and performance will affect commitment/choice and thereby performance. The values of outcome, however, may include both recognition and monetary reward.

A study by Mueller [36] found that the relationship between competition and goal difficulty leads to better performance, but there was no evidence of a relationship between commitment and competition. The above

described internal factors, external factors, and interactive factors are used during cognitive processing to judge the value of goal commitment. Locke et al [30] adopted a different approach to categorize the distal antecedent factors of goal commitment. The antecedent variables in Locke et al [30], however, are very similar to those proposed by Hollenbeck and Klein [17].

Klein et al [24] conducted a meta-analysis of the distal antecedents of goal commitment. They found that situation factors had a higher correlation with goal commitment than personal factors. Task complexity, social influence, supervisor supportiveness, and volition have significant correlations of -0.50, 0.45, 0.38, and 0.37 respectively, while other variables had correlations smaller than 0.20. Thus, this study will focus on task complexity, social influence, supervisor supportiveness, and volition influencing the goal commitment.

## 2.2 Team Commitment

The present study focuses on commitment to a goal and also on commitment to a team membership. Team commitment characteristics, accordingly, include the determination and the persistence to achieving a team's goals and the strong desire to maintain membership in a team. Bishop and Scott [2] suggested that satisfaction with co-workers and intersender conflict influences the desire to maintain membership in a team, which in turn impacts the team commitment. In a situation where team performance benefits each member, individuals are likely to replicate the effort of teammates to create an equitable exchange relationship. Experiencing a good social relationship with team members will enhance team commitment.

Bishop and Scott [2] examined two types of role conflict: Intersender and Resource-related conflict. Intersender conflict is posited to have a negative relationship with team commitment either directly or through satisfaction with teammates. Resource-related conflict is posited to have a negative relationship with organization commitment and satisfaction with supervisors. Intersender conflict occurs when members cannot behave in a way that will satisfy incompatible expectations among teammates about their members. Bishop and Scott [2] also argued that high perceived task interdependence would lead members to be more aware of the importance of their contribution to the team as well as to the organization; members, thus, increase their positive affect on the team and their effort on the task [35].

In summary, the factors that will influence team commitment are those that have an impact on the persistence to achieving team's goals and the strong desire to maintain membership in a team. We suggest integrating the factors satisfaction, intersender conflict, and perceived task interdependence, included in the model of Bishop and Scott [2], with the factors task complexity, social influence, supervisor supportiveness, and volition, included in goal setting theory.

## 2.3 Media Selection and performance

Over the last two decades, researchers in organization communication have developed theories to understand and explain the choice of communication media in an organization [7]. Carlson and Davis [6] in their study of a public agency found that ease of accessibility is the default selection criterion for media choice. People, therefore, view the chosen media to be effective enough to be used in a particular situation or for a particular task if it achieves the expected outcomes/performance. As a result, they do not choose the most effective media. Another explanation based on cost minimization was provided by Swanson [40], people are likely to choose inferior quality information because its use requires less effort or work than the use of high quality information. These explanations, however, may not apply to all situations. Other plausible variables that can explain the selection of media are, information quality, message personalization, and social influence.

Even though, there are many plausible explanations for media choice, the main reason for using a particular media is that it allows people to successfully exchange or acquire the meaning of information. Exchange of the meaning of information and subjective views is required in equivocality situation<sup>1</sup> such as problem definition or resolution of disagreement. Acquisition of the meaning of information, on the other hand, is required when the members are in the uncertainty situation<sup>2</sup>. Media richness theory [8] hypothesizes that communication would be effective if the media used is congruent with the task. The theory measures the richness of each medium based on its ability to give immediate feedback, the variety of communication cues, the personalization of the medium, and the language variety. Thus, rich media enable users to provide quick feedback about their understanding or ambiguity of opposing parties' messages, and to transmit cues in multiple, concurrent ways. Similarly, social presence theory views the capabilities of each medium to permit users to perceive others as being psychologically present [9]. Therefore, rich media usually can be viewed as a media that also provides a high degree of social presence.

Several studies that examined the central hypothesis of richness theory that matching media with the task leads to communication effectiveness, however, found that in some situations, a mismatch of media with the task demand still resulted in high performance. Dennis and Kinney [9] found that the success of communication might not be determined by the richness construct but the more fundamental constructs of feedback and social presence cues. Other factors that influence the performance are organizational norms, personal characteristics and shared histories among group

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<sup>1</sup> Equivocality Situation means ambiguity, confusing, disagreement, and lack of understanding tasks and information.

<sup>2</sup> Uncertainty Situation means that there is not enough information to make a decision or to perform a task.

members [13] [37] [38]. Kock [25] suggest that the reasons subjects using lean media have the same level of performance, as subjects using rich media are that with lean media, an extra effort to overcome problems due to the limitations of media capabilities is necessary.

Using Hermeneutic concepts to interpret a collection of exchanged e-mail messages among a group of managers, Lee [27] concluded that electronic mail is neither rich nor lean media because richness or leanness is not a property of the e-mail medium, but a property of the interaction of the user with e-mail medium in organizational context. Lee suggested that, to have rich communication using e-mail, e-mail receivers must not be passive recipients of data but active producers of the meaning.

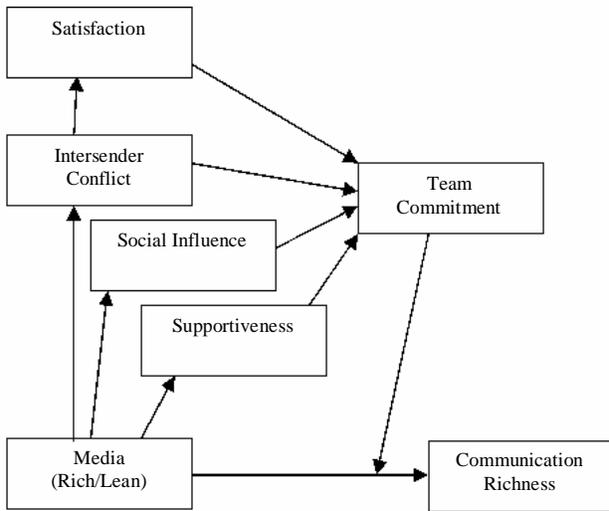
In summary, we can conclude that people usually select the media that are easier to access and are effective enough to get the job done. In some situations, however, people require more effort to interpret the meaning of information or interact with counterparts during the decision making if one medium is used over another. Thus, it is interesting to examine team performance under use of different media when one or more members of the team have a low commitment to the team. Also it will be interesting to examine how the richness/social presence of media affects the team commitment.

## 2.4 Research Model

Based on the foregoing discussions and extending the theoretical bases, we propose a research model (shown in figure 1) to examine the role of media type on the communication richness when team members have low commitment to the collaborative team projects in eCollaboration environment. The study by Kock [25] found that subjects using lean media put an extra effort to collaborate on equivocal tasks. Burke and Chidambaram [4] found that subjects using lean media are focused on the task at hand that leads to better performance. The behaviors of subjects in both studies can be explained when all subjects accept and are committed to the assigned tasks and goals.

We argue that individuals who are members of multiple different teams and are working on individual projects/tasks concurrently are unlikely to put the same intensity and focus in every task. According to goal setting theory, given that all teams have the same ability and use the same technology, performance of teams/groups varies due to the difference in the level of effort intensity. The goals that the team sets to pursue will influence the intensity of effort required to accomplish the goal. For goals to have an impact on performance, however, every team member must accept and commit to the goals (e.g. [30] [31] [32]).

Commitment and acceptance of team goals influences and motivate individuals to expense their cognitive/physical effort. Research in Group Decision Support Systems (GDSS) has shown that group members with the focus and attention on the task at hand would lead to higher decision quality [10]. Thus, we believe



**Figure 1: A Research Model**

that individuals using lean media can put effort and focus to successfully collaborate on equivocal tasks, when the individuals have a high commitment to the team goals.

On the contrary, individuals using lean media will not put enough effort and focus to successfully collaborate on equivocal tasks when they do not have commitment or have low commitment to the team goals. A sign of low commitment is, for example, when individuals delay their response to the team members or ignore the requests of others. We posit that team members will perceive the rich communication with individuals who have high commitment and will perceive the lean communication with individual who have low commitment to the team goal. Thus, team commitment has a moderating effect on the communication richness achieved by the media (as shown in figure one). As discussed earlier based on the previous research important factors affecting team commitments are: Satisfaction, Intersender conflict, Social Influence, and supportiveness (as shown in figure one). These factors in turn are affected by richness of the communication media in eCollaboration environment. Thus, there exists a reciprocal relationship as shown in figure 1. The next section proposes a set of Hypotheses and briefly describes a planned experimental study.

### 3. Hypotheses & Proposed study

Based on commitment literature, individuals with high commitment will put more effort in collaborating among team members to achieve a team goal than those with low commitment, hence our first hypothesis is:

*H1: Use of lean media under high commitment situation will be perceived as richer communication than use of lean media under low commitment situation.*

Discrepancies in feedback between performance and effort are an important factor affecting goal commitment (e.g. [22] [44]). The tasks with the lowest discrepancy

will receive priority if the tasks have the same amount of incentives. Large discrepancies in feedback may indicate that the goal is impossible or very difficult to attain. With limited resources (time and effort), individuals have to lower goal commitment of other tasks to meet the commitment required by a task that is determined to be more important. We can conclude that the feedback using either rich media or lean media should not differ in their impact on team commitment.

In the GDSS research, however, social presence has a significant effect on individual involvement in generating and evaluating ideas. In meetings anonymous individuals generate more ideas than those with names identified [21]. Jessup et al. [21] also found that individuals in a face-to-face meeting are more threatened by possible criticism. In addition, social factors such as social pressures and social norms are shown to influence individual behaviors in selecting media use. Social impact theory [26] suggests that pressure to act is a function of the interpersonal power, immediacy, and group member status. Based on these studies, we can imply that the feedback and praise in high social presence environments are more persuasive or have a greater effect on individuals' behavior than the feedback and praise in a low social presence environment.

According to media richness and social presence theories, each media has a different capacity to transmit information, which in turn exhibits differences in social presence and richness (e.g. [4] [8]). The theory ranged the richness of each medium based on its abilities to give immediate feedback, the variety of communication cues, the personalization of the medium and the language variety. The rich media exhibit more social presence and awareness of other participants. We argue that rich media are likely to create more pressure for individuals to follow group norms than lean media does. Team members and the "team leader" can use the feedback and a variety of communication cues to convey the supportiveness and social influence to affect individual's commitment to the team, which will be confounded when they are using rich media instead of lean media. Thus, we hypothesize that:

*H2.a: Individuals with low commitment using rich media will feel greater social influence from team members than those with low commitment using lean media.*

*H2.b: Individuals with low commitment using rich media will feel more support from team members and team leaders than those with low commitment using lean media.*

*H2.c: The perceived social influence will have an effect on individual's commitment to the team goal.*

*H2.d: The perceived team supportiveness will have an effect on individual's commitment to the team goal.*

Bishop and Scott [2] found that intersender conflict has significant indirect effect on team commitment and significant direct effect on satisfaction with the team members. Satisfaction was also found to significantly

influence team commitment. Individuals perceive to have intersender conflicts in a team when they feel that two or more members give them different requests, answers, or agreements. These differences or conflicts may leave team members in a state of confusion and unsure about what to do next, which leads to a lowering of the goal expectation, the effort, and the team commitment [2]. We propose that the faster the intersender conflicts are resolved, the less effect the conflict will have on the team commitment and the satisfaction with team members. Rich media, which provides a variety of cues and immediate feedback, should help individuals in resolving these conflicts faster than with lean media. Since, in case of lean media individuals can postpone or delay their response, especially when they already have a low commitment to the team. In addition, the slow response to the request and to the slow conflict resolution process will lead to individuals' frustration and adversely effect satisfaction with the team members. Thus, we can posit that intersender conflicts will have less confounding effect on the satisfaction with team members when rich media is used.

*H3a: Teams using rich media have smaller negative effects of the intersender conflicts on satisfaction with the team members than teams using lean media.*

*H3b: The intersender conflicts will have a negative effect on team commitment.*

In situations where individual with low team commitment decides not to respond at all - e.g. do not show up at the meeting, show up at the meeting but do not participate, or do not reply back, team members using rich media will feel more offense to the low commitment individuals' behavior than team member using lean media. As a result, we anticipate that we will not find the effect proposed in the hypothesis 3 if the individuals decide not to respond to the requests of the team members.

To test the proposed hypotheses, about 180 student subjects who are enrolled in internet and non internet classes will be used for this study. The design of planned research study is a 2 (high commitment, low commitment) x 2 (rich media, lean media) matrix with a between subject design for the team commitment. Subjects will be assigned randomly to a team. Subjects will be manipulated using incentive, task difficulty, and perceived task independence to have high commitment to the first project and have low commitment to the second project.

## 4. Conclusions

With the increasing interest in application of eCollaboration technology at the global level for a variety of tasks it is important to understand the factors that affects the performance of these global teams. Even though many studies have focused on media richness the

impact of team commitment in eCollaboration have not been studied. As can be seen form the conceptual model presented in this paper there is a reciprocal relationship between the media richness and team commitment. Based on the theoretical model a set of hypothesis has been derived. The model explains intricate relationships between various factors affecting team commitment and how media richness can impact these factors.

## References

- [1] Bandura, A. *Social Foundation of Thought and Action: A Social Cognitive Theory*, Englewood Cliffs, NJ: Prentice Hall, 1986.
- [2] Bishop, J.W. & Scott, K.D. "An Examination of Organizational and Team Commitment in a Self-Directed Team Environment," *Journal of Applied Psychology*, 2000, 85(3), 439-450.
- [3] Boudreau, M; Loch, K.D.; Robey, D.; & Straud, D. "Going Global: Using Information Technology to Advance the Competitiveness of the Virtual Transnational Organization," *Academy of Management Executive*, 1998, 12:(4), 120-128.
- [4] Burke, K. & Chidambaram, L. "How Much Bandwidth Is Enough? A Longitudinal Examination of Media Characteristics and Group Outcomes," *MIS Quarterly*, 23(4), 1999, 557-580.
- [5] Campbell, D.J. "Determinants of Choice of Goal Difficulty Level: A Review of Situational and Personality Influences," *Journal of Occupational Psychology*, 55(2), 1982, 79-95.
- [6] Carlson, J.R. & Davis, G.B. "An investigation of media selection among directors and managers: From "self" to "other" orientation," *MIS Quarterly*, 22(3), 1998, 335-362.
- [7] Carlson, J.R. & Zmud, R.W. "Channel expansion theory and the experiential nature of media richness perceptions," *Academy of Management Journal*, 42(2), 1999, 153-170.
- [8] Daft, R.L.; Lengel, R.H.; & Trevino, L.K. "Message Equivocality, Media Selection, and Manager Performance for Information Systems," *MIS Quarterly*, 11(3), 1987, 355-366.
- [9] Dennis, A.R. & Kinney, S.T. "Testing media richness theory in the new media: The effects of cues, feedback, and task equivocality," *Information Systems Research*, 9(3), 1998, 256-274.
- [10] DeSanctis, G.L. & Gallupe, R.B. "A Foundation for the Study of Group Decision Support Systems," *Management Science*, 33(5), 1987, 589-609.
- [11] Donoan, J.J. & Radoseich, D.J. "The Moderating role of Goal Commitment on the Goal Difficulty-Performance Relationship: A Meta-Analytic Review and Critical Reanalysis," *Journal of Applied Psychology*, 83(2), 1998, 308-315.
- [12] Earley, P.C. & Kanfer, R. "The Influence of Component Participation and Role Models on Goal Acceptance, Goal Satisfaction and Performance," *Organizational Behavior and Human Decision Processes*, 36(3), 1985, 378-390.
- [13] Fulk, J. & Boyd, B. "Emerging Theories of Communication in Organizations," *Journal Of Management*, 17(2), 1991, 407-446.
- [14] Hackman, J.R. *The Design of Work Teams, in Handbook of Organization Behavior*, J.W. Lorsch (Ed.) Englewood Cliffs, NJ: Prentice Hall, 1987, 315-342.
- [15] Hall, D.T. "A Theoretical Model of Career Subidentity Development," *Organizational Behavior and Human Performance*, 6(1), 1971, 50-76.

- [16] Hall, D.T. & Foster, L.W. "A Psychological Success Cycle and Goal Setting: Goals, Performance, and Attitudes," *Academy of Management Journal*, 20(2), 1977, 282-290.
- [17] Hollenbeck, J.R. & Klein, H.J. "Goal Commitment and the Goal Setting Process: Problems, Prospects, and Proposals for Future Research," *Journal of Applied Psychology*, 72(2), 1987, 212-220.
- [18] Hollenbeck, J.R.; Williams, C.L.; & Klein, H.J. "An Empirical Examination of the Antecedents of Commitment to Difficult Goals," *Journal of Applied Psychology*, 74(1), 1989, 18-23.
- [19] Jain, H.K. & Song, J. Location Economics and Global Software Development Centers, in *Global Information Technology and Electronic Commerce*, P.C. Palvia, S.C. Palvia, and E.M. Roche (Ed.) Marietta, GA: Ivy League Publishing Limited, 2002, 447-462.
- [20] Javenpaa, S.L.; Knoll, K; & Leidner, D.E. "Is Anybody Out There? Antecedents of Trust in Global Virtual Teams," *Journal of Management Information Systems*, 14(4), 1998, 29-64.
- [21] Jessup, L. M.; Connolly, T.; & Galegher, J. "The effects of anonymity on GDSS group process with an idea-generating task," *MIS Quarterly*, 14(3), 1990, 313-321.
- [22] Kernan, M.C. & Lord, R.G. "Effects of Valence, Experiences, and Goal-Performance Discrepancies in Single and Multiple Goal Environments," *Journal of Applied Psychology*, 75(2), 1990, 194-203.
- [23] Kinney, S.T. & Watson, R. "The Effects of Medium and Task on Dyadic Communication," *Proc. International Conf. On Information Systems*, Dallas, TX, 1992, 107-117.
- [24] Klein, H.J.; Wesson, M.J.; Hollenbeck, J.R.; & Alge, B.J. "Goal Commitment and the Goal-Setting Process: Conceptual Clarification and Empirical Synthesis," *Journal of Applied Psychology*, 84(6), 1999, 885-896.
- [25] Kock, N. "Can Communication Medium Limitations Foster Better Group Outcomes? An Action Research Study," *Information Management*, 15(4), 1998, 115-142.
- [26] Latane, B. "The Psychology of Social Impact," *American Psychologist*, 36(4), 1981, 343-356.
- [27] Lee, A. "Electronic mail as a medium for rich communication: An empirical investigation using hermeneutic interpretation," *MIS Quarterly*, 18(2), 1994, 143-157.
- [28] Locke, E.A. "Toward a theory of task motivation and Incentives," *Organizational Behavior and Human Performance*, 3(2), 1968, 157-189
- [29] Locke, E.A.; Frederick, E.; Lee, C.; & Bobko, P. "Effects of Self-Efficacy, Goals, and Task Strategies on Task Performance," *Journal of Applied Psychology*, 69(4), 1984, 241-251.
- [30] Locke, E.A.; Latham, G.P.; & Erez, M. "The Determinants of Goal Commitment," *Academy of Management Review*, 13(1), 1988, 23-39.
- [31] Locke, E.A. & Latham, G.P. *A Theory of Goal Setting and Task Performance*, Englewood Cliffs, NJ. Prentice Hall, 1990.
- [32] Locke, E.A., Shaw, K.N.; Saari, L.M.; & Latham, G.P. "Goal Setting and Task Performance: 1969-1980," *Psychological Bulletin*, 90(1), 1981, 125-152.
- [33] Martin, B.A. & Manning Jr., D.J. "Combined Effects of Normative Information and task difficulty on the goal commitment-performance relationship," *Journal of Management*, 21(1), 1995, 65-80.
- [34] McQuaid, M.J.; Briggs, R.O.; Gillman, D; Hauck, R.; Lin, C.; Mittleman, D.D.; Nunamaker, J.F.; Ramsey, M.; & Romano, N. "Tools for Distributed Facilitation," *Proceedings of the 33rd Hawaii International Conference on System Science*, 2000.
- [35] Morris, J.H. & Steers, R.M. "Structural Influences on Organizational Commitment," *Journal of Vocational Behavior*, 17(1), 1980, 50-57.
- [36] Mueller, M.E. "The Effects of Goal Setting and Competition on Performance: A Laboratory Study," *Unpublished Master's Thesis*, U of Minnesota.
- [37] Ngwenyama, O.K. & Lee, A. "Communication richness in electronic mail: Critical social theory and the contextuality of meaning," *MIS Quarterly*, 21(2), 1997, 145-167.
- [38] Rice, R.E. "Task Analyzability, Use of New Media, and Effectiveness: A Multi-Site Exploration of Media Richness," *Organization Science*, 3(4), 1992, 475-500.
- [39] Schmitz, J. & Fulk, J. "Organizational Colleagues, Media Richness, and Electronic Mail: A Test of the Social Influence Model of Technology," *Communication Research*, 18(4), 1991, 487-523.
- [40] Swanson, E. B. "Information Channel Disposition and Use," *Decision Sciences*, 18(1), 1987, 131-145.
- [41] Tubbs, M.E. "Goal Setting: A Meta-Analytic Examination of the Empirical Evidence," *Journal of Applied Psychology*, 71(3), 1986, 474-483.
- [42] Tubbs, M.E. "Commitment as a moderator of the goal-performance relation: A case for clearer construct definition," *Journal of Applied Psychology*, 78(1), 1993, 86-97.
- [43] Valacich, J.S.; Mennecke, B.E.; Wachter, R.M.; & Wheeler, B.C. "Extension to Media Richness Theory: A Test of the Task-Media Fit Hypothesis," *Proc. Twenty-Seventh Hawaiian International Conf. On System Science*, Maui, Hawaii, 1994, 11-20.
- [44] Vance, R.J. & Colella, "A. Effects of Two Types of Feedback on Goal Acceptance and Personal Goals," *Journal of Applied Psychology*, 75(1), 1990, 68-76.
- [45] Yukl, G.A. & Latham, G.P. "Interrelationships Among Employee Participation, Individual Difference, Goal Difficulty, Goal Acceptance, Goal Instrumentality, and Performance," *Personnel Psychology*, 31(2), 1978, 305-323.
- [46] Wofford, J.C.; Goodwin, V.L.; & Premack, S. "Meta-Analysis of the Antecedents of Personal Goal Level and of the Antecedents and Consequences of Goal Commitment," *Journal of Management*, 18(3), 1992, 595-615.

# Building and Managing Social Capital in Virtual Communities

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## Abstract

We suggest that the development and sustainability of social capital is related to the social context in which individuals, groups or firms operate. Therefore, we argue that there is a direct relationship between how one party conceives to be benefited from being part of another group or network and its implication for the development of social capital. In this paper, we use a social exchange metaphor for understanding the challenges related to the management of social capital in a virtual community. First, we provide an overview of virtual community and discuss the application of Information and Communication Technology (ICT) for supporting this type of community. Second, we address the management challenges for the development process of social capital from a sociological standpoint. Lastly, we suggest the implications of study for the management of social capital in virtual community. The following research questions guide this study—What is/are the key strategic challenges for the management of social capital in virtual community? How do establish an effective knowledge sharing process for supporting the development of social capital in a virtual community? How can the social exchange metaphor help in managing the strategic challenges related to the formation of social capital in a virtual community?

## 1. Introduction

Internet is increasingly seen as a useful mode to share data, collaborate on research, and exchange messages for both the organizational and virtual community (VC). A set of rules as a guiding principle for individuals to act or participate is common to both VC and organizational community [29][55]. VC evolved as a result of the implementation of Electronic Information Exchange (EIES) systems for computerized conferencing in 1976 [26]. It is observed for the case of EIES that a collective intelligence capability for decision-making was cultivated through this implementation. However, understanding how individuals interact and exchange information through the use of Internet and its implications on the formation of social capital is limited. Social capital can be essentially viewed as network of contacts of the individuals or participating organizations in an exchange [55]. Therefore, we highlight the need for understanding

the mechanics of exchange, coercion and conflict between contacts or network of contacts as a useful paradigm for this social capital formation research in VC.

A study by Turoff [52] and Burnett [9] suggests that the expansion of computer-mediated communication (CMC) provides a platform for individuals to meet, communicate, collaborate, socialize, and shop. Smith [48] highlights that the sense of belonging and concrete experience of social networks (and the relationships of trust and tolerance) can bring great benefits to people. This eventually serves as motivating factors for people participating in a VC. Recent studies on VC also suggests that gaining access to new knowledge of product, process, competitors and markets can also be seen as motivating factors for people participating in VC [1]. Walther [55] further highlights that ICT infrastructure needs to be in place so that the VC can emerge. However, this study also argued that social structure of the networks needs careful examination, which serves as a basis for understanding the utilization of ICT for supporting the VC [55]. We argue here that knowledge sharing or KS is an important part in the formation process of social capital. KS involves a relationship between actors (same as people or individuals) that is embedded in a structure of other social relationships [17][3]. Boer et al. [3] suggests that these ongoing social relationships provide the constraints and opportunities for individuals, organizations and knowledge, and provides a basis for understanding the dynamics of KS in VC. Individuals establish their network of contacts through this sharing. Therefore, KS is seen as essentially a social phenomenon. Social capital is increasingly considered as significant part of other organizational asset such as financial, human, intellectual, and other capitals in today's communities. It is regarded as the social fabric or glue that holds communities and other social networks together [8]. Smith [48] suggests that the process for fostering and sustaining social capital lies in the interaction, which enables people to build communities, to commit themselves to each other, and to knit the social fabric. Prior studies have examined social capital from three perspectives: (i) the density of social networks that people are involve in; (ii) the extent to which they are engaged with others in informal social activities; and (iii) their membership of groups and associations [7][13][48]. Therefore, we suggest that an effective knowledge

sharing or KS is critical to the development and sustainability of social capital in VC. In this paper, we address the process for building social capital through KS in VC. We first define the concept of VC and suggest that this study on VC can essentially follow the patterns of organizational community building research. Second, we present the significance of KS as an activity for fostering the development and sustainability of social capital in VC. Why is the understanding of KS critical for the development and sustainability of social capital in VC? And how can this new form of informal community establish its social network in order to build and sustain the social capital? Understanding this phenomenon from both a theoretical and an applied perspective calls for an examination of the conceptual issues related to the formation of community and in particular VC.

## 2. Conceptual Issues for Understanding Virtual Communities

We first introduce the concept of *community* before addressing the conceptual issues for VC. Community is associated with a place and a name in his thought [35]. Nelson et al. [35] further added that community is where one goes to shop, to attend a show, to meet friends, or simply to loaf. The common-sense concept of community is that it involves an area, people, and the relationships among people (e.g. structure). The elements of structure in a community consist of groups, formal organizations, institutions, division of labor, values, social differentiation, and functions. Therefore, community may be formally defined as the structuring of elements and dimensions to solve problems that can be solved within the local area [35].

VC is defined as a social entity where a number of people relate to one another by the use of a specific technology [45][24][28][47][49]. In addition, a VC is considered to be a source from which individuals seek social support using computer-supported communications [53][22]. Hiltz and Wellman [20] argued that the difference between communities' off-line and computer-supported communities is that VC is more dispersed in space and time, but more closely knit. It is further suggested that the members of a VC is more heterogeneous in their characteristics and homogeneous in their attitudes [20]. Furthermore, Igbaria [22] suggests that VC is a group of people who may or may not meet one another face-to-face, and who exchange words and ideas through the mediation of computer networks and bulletin boards. VC is therefore defined as information technology based system which supports the communication and social relationships between people whether individuals or groups of people.

## 3. Building Social Capital Through Knowledge Sharing

In this section, we discuss three issues related to the development and sustainability of social capital in a VC. We provide an introduction to social capital first. Secondly, we discuss KS in the context of developing and sustaining social capital in VC. Thirdly, we provide a conceptual framework highlighting the process involved in the formation of social capital.

The notion of social capital was first introduced by Lyda Judson Hanifan's discussions of rural school community centers [48]. The term 'social capital' was used to describe tangible substances, which count for most in the daily lives of people. The major concern was on the cultivation of good will, fellowship, sympathy and social intercourse among those that make up a social unit [48]. Most recently, Putnam [41][43] initiated social capital as a focus for research and policy discussion. However, other prominent contributions came from [23] study in relation to urban life and neighborliness. Bourdieu [4] first used the term to refer to the advantages and opportunities accruing to people through membership in certain communities. With regards to social theory, Coleman [10] used the term social capital in his discussions of the social context of education. Social capital is also used to describe resource of individuals, which emerges from their social ties [10]. Coleman [10] argued that social capital differs from the financial capital found in bank accounts and the human capital inside people's heads. It is further suggested that social capital inheres in interpersonal relations and describes the durable networks, which form social resources through individuals, and groups strive for mutual recognition [10]. As such, social capital is the necessary infrastructure of civic and community life that generates 'norms of reciprocity and civic engagement.'

Social capital is seen as a core concept in business, political science, healthcare, and sociology. It can be viewed as a common framework for understanding the depth of a community's social connectedness. Putnam [42] suggests that social capital refers to features of social organization such as networks, norms, and social trust, which facilitates coordination and cooperation for mutual benefit. It can also be referred to as institutions, relationships, and norms that shape the quality and quantity of a society's social interactions [50][51]. Social capital is not just the sum of the institutions, which underpin a society-it is the glue that holds them together [51]. Furthermore, Cohen and Prusak [12] suggests that social capital consists of the stock of active connections among people--the trust, mutual understanding, and shared values and behaviors, which bind the members of human networks and communities and make cooperative action possible. Jacobs [23] defines social capital as neighborhood networks. Networks are not merely the

result of historical accident; they came about as individuals spend time and energy to connect with others.

So, why is the understanding of knowledge sharing (KS) important to the formation of social capital? What is relationship between KS and formation of social capital? How can the effective KS systems help develop and sustain social capital in VC? According to the *theory of organizational knowledge creation*, knowledge is generated through a process of interaction of tacit and explicit knowledge [36][37][27]. Knowledge is either transformed within one single person or among a group of people. Therefore, it is important to note that knowledge is neither given nor pre-defined, but created through a process of individual interpretation and personal construction [44].

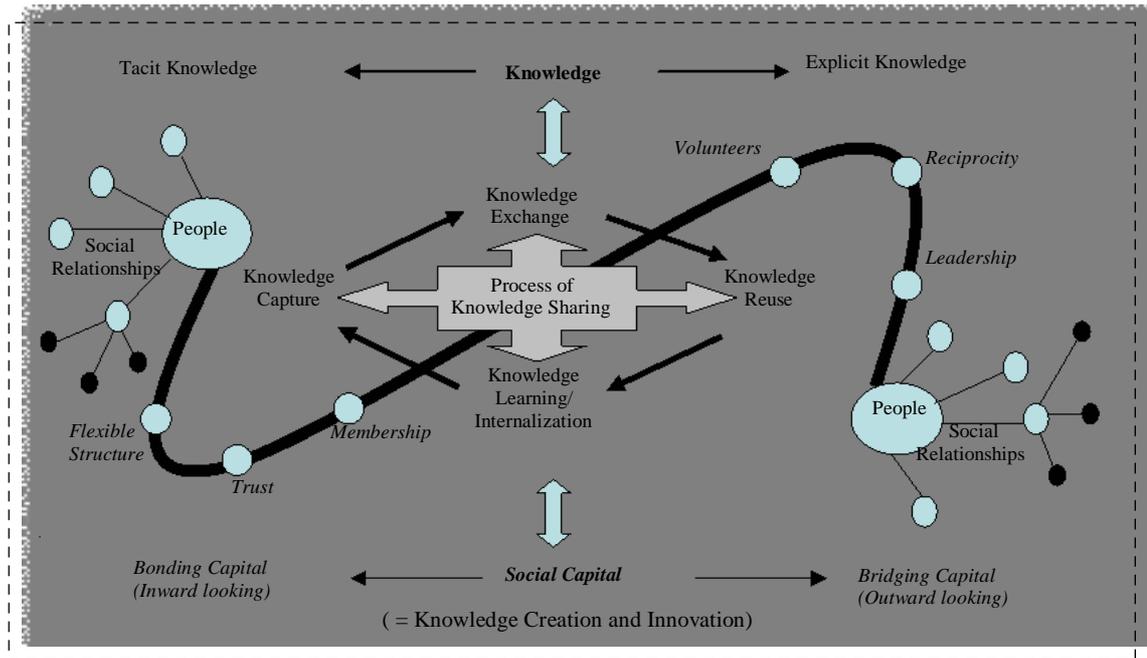
Here, we discuss two broad types of knowledge-- explicit and tacit [37]. Explicit knowledge is knowledge that can be expressed in words and numbers, and shared in the form of data, scientific formula, specifications, and manuals [21]. Explicit knowledge is packaged, easily codified, communicable and transferable. An example of explicit knowledge is the manuals, which accompanies the purchase of electrical goods--microwave oven. On the other hand, tacit knowledge is considered to be highly personal, hard to formalized and difficult to communicate or share with others [21]. Subjective insights, intuitions, and hunches fall into this category of knowledge. Tacit knowledge deals with individual's actions and experience, as well as in the ideals, values, or emotions he or she embraces. An example of tacit knowledge is knowledge a chemistry professor may have on carrying out experiments of certain substance.

We suggested earlier that the development and sustainability of social capital for both the organizational and virtual community is essentially a social process. Social capital is developed through the community who shares knowledge about certain products, services, and markets to a group of people interested in common goals. It is therefore through an effective KS which individuals or organizations are able to develop and sustain the social capital in VC.

So, what is the process for building a sustainable social capital for VC? Here, we provide a conceptual framework called "*Process of building social capital*" in the context of virtual community (refer to Figure 1). This framework was adapted from an organizational context, and by integrating the ideas, we attempt to explore and apply it in the context of VC. This framework begins with the first layer of the types of knowledge-- tacit and explicit. We argue that a full understanding of these two types of knowledge will facilitate differentiating how knowledge is exchanged and shared among people in organizations. To illustrate this further, we introduce the KS process developed by [33]. We highlight here that a framework for evaluating and incorporating new experiences and information is thus crucial. This is crucial as knowledge can be viewed as a mix of experience, values, contextual information, and expert insights.

The case of MITRE [33] suggests four perspectives for understanding knowledge flows and collections-- individuals or groups exchange it with each other (e. g. knowledge exchange), record it or capture it (e. g. knowledge capture), reuse the recorded knowledge assets (e. g. knowledge reuse), and finally, generate new knowledge as they internalize learning into the way they think and know (e. g. knowledge internalization).

Giddens [15] suggests that structuration is important as it integrates the concept of knowledge and social relationships. He further argued that the relationship between people is established as soon as they share knowledge with one another [15]. This relationship between people consequently influences the way knowledge is being shared. Knowledge can be shared between people through face-to-face, or through technology either asynchronous or synchronous (which is known as virtual community). In our model (see Figure 1), we explicitly show "people" linked to several nodes indicating the networks based on the establishment of social exchanges of goods and behaviors where they are assumed to have the reciprocal element when they determine the value of knowledge each of them has. The exchange of knowledge is further been moderated by the elements of power, control and benefits by each exchanging party as highlighted in the elementary theory of the social structure [54].



**Figure 1. A conceptual framework for building social capital [55]**

In Figure 1, there is a dark line with several key nodes representing the ‘social capital’ variables, which is directly connected to the people with their own social bonds, norms and networks, is presented. We suggest that these antecedents consisting of six key variables in turn will facilitate the final process--the knowledge sharing and creation of social networks and exchanges for building social capital in VC. Subsequently, this outcome--social capital is framed as the last layer of our proposed conceptual framework (see figure 1) where social capital can be seen as having two additional dimensions--bonding (or exclusive) and bridging (or inclusive). The former may be more inward looking and have a tendency to reinforce exclusive identities and homogeneous groups. While the latter may be more outward looking and encompass people across different social divides [43]. Putnam [43] further explains that bonding capital is good for under girding specific reciprocity and mobilizing solidarity while bridging networks, by contrast, are better for linkage to external assets and for information diffusion. Further, bridging social capital can generate broader identities and reciprocity, whereas bonding social capital bolsters our narrower selves [43, p. 22]. In the next section, we discuss the dimensions of social capital.

#### **4. Understanding the Dimensions of social Capital**

Nahapiet and Ghoshal [34] divide social capital into three dimensions (different from Putnam’s dimensions)--

structure, cognitive and relational in their comprehensive review of the conceptual literature. Structural social capital refers to the ways in which motivated recipients gain access to actors with desired sets of knowledge and intellectual capital. This dimension of social capital is usually studied using a network approach. In the network approach, the frequency of contact and resulting social distance among actors in a particular firm or organizational field are plotted to form a web-like diagram illustrating actor interaction patterns. The objective of this type of research is to determine the central nodes of the network or the critical communicators, which is helpful in understanding communication patterns as well as resultant organizational behaviors such as power positioning and knowledge flows [5][13].

In contrast, cognitive social capital approach recognizes that exchange occurs within a social context, which is both created and sustained through ongoing relationships [34]. Similar to the notion of community of practice [6] and some aspects of virtual community, cognitive social capital refers to the shared meanings which can be created through stories and continual discussions within a specific, often clearly defined group. These shared meanings are self-reinforcing in that participation as the community is dependent upon an *a priori* understanding of the context and continual contribution to the on-going dialogues.

The third dimension of social capital deals with the relational aspects, which is concerned with the underlying

normative dimensions that guide exchange relationship behaviors. Norms exist when the socially defined right to control an action is not held by the individual actor, but instead is held by others [11]. Therefore, norms represent degrees of consensus and hence are powerful although fragile form of social capital [34].

## 5. Managing the Challenges of Social Capital

There are a few challenges that exist in each of the dimensions mentioned above for virtual communities seeking to create, sustain, and exploit their social capital. As we understand, connections made through face-to-face interactions are necessary for building social capital. Due to the fact that face-to-face interactions are not always practical or possible in virtual communities, we must look for ways to build and leverage social capital virtually [31].

### 5.1 Structural Challenges

A study by Rocco [46] suggests that the level of trust that exists in virtual workgroups could be measurably improved by even a single face-to-face interaction at the beginning of the project. But barriers of time, distance, and physical setting can make such interactions difficult to accomplish.

Another aspect of this challenge is that when people are across multiple virtual communities, it is difficult for them to make connections with others having a specific expertise. Organizations have attempted to solve the problem by developing an electronic “yellow pages” and dedicated skill directories where individual could provide data regarding their level of expertise on a variety of topics. While some of these efforts proved useful, many of them did not achieve their desired results [31]. This is because these repositories require users to manually update their expertise profiles regularly, which individuals often failed to do so.

### 5.2 Cognitive Challenges

One of the greatest disappointments encountered in large organizations is the difficulty of ensuring everyone is “reading off the same page.” Shared understanding is not guaranteed even when people are physically together, observing and discussing in the same environment [31].

In a virtual world, a number of barriers make it difficult to ensure that each member in a conversation has appropriate contextual clues necessary to develop mutual understanding and share knowledge. First, communicating across time and space often introduces cultural and linguistic differences that can distort the intended meaning. Talking with someone who is less familiar with your language can be difficult in face-to-

face setting; but trying to do so without any facial expressions, and gestures would be even more difficult.

Lesser and Cothrel [31] points out that another barrier facing the development of social capital in a virtual community is the difficulty associated with building a common set of assumptions and understandings. In physical settings, the interaction around common artifacts makes it easier to develop reference points that everyone in a conversation can share.

### 5.3 Relational Challenges

The last challenge involves relationships in virtual environments. As Lesser and Cothrel [31] states that connections are easy but relationships are hard. The Internet age has given rise to a whole range of questions about how we evaluate the trustworthiness of others that we cannot see, and perhaps have never met. In this regard, [cited in 31,p.73] suggest that “these issues have to do with information quality, bias, endorsement, privacy, and trust – the fundamental values of society, much misunderstood on the web, and also highly susceptible to exploitation by those who can find a way.” Furthermore, the public nature of many virtual conversations, such as chatting, can leave individuals exposed to attacks by others, many of them anonymous and not controlled by the norms and responsibilities of traditional social interactions. According to Blanchard and Horan [2], this form of attack known as “flaming,” can lower the level of social trust within a virtual environment and can inhibit the participation of individuals seeking more forthright relationships. In the next section, we suggest some implications in building social capital in virtual communities.

## 6. Implications for Social Capital Building in Virtual Communities

Nahapiet and Ghoshal [34], and Burt [8] suggests that key idea behind social capital building is that networks of relationship involve a valuable resource for providing people with privilege access to information and opportunities. The interpersonal dynamics between individual of networks are equally important as having the social network of individuals. Thus, the implication of positive interactions that take place between individuals in the network is significant. This leads to the success of building the social capital in both the organizational context as well as the VC [30]. We suggest that the development of social capital implies creating the opportunity, the motivation and the ability for knowledge sharing in VC. Therefore, our propositions have some complex implications in the sense that VC emerges as a new form of community, which exists without a formal structure and it transcends across space, time and distance. Furthermore, framing these antecedents based on the

organizational perspectives presents and contributes a new outlook of the key idea of social capital building and social exchange network. But more importantly, it helps to promote a better understanding of the process of building the social capital in a VC.

A study by Fairtlough [14] suggest that when a high degree of innovation and speed is required, the elimination of job descriptions, enhanced flexibility and initiative, as well as increased self-motivation would be the key success to effective organization. In line with these suggestions, we thus propose:

Po: Flexibility and mobility of a VC structure allows sharing of knowledge when exchange, conflict, and coercive relations exist through sanctions and thus able to build successful social capital.

Putnam [43] promotes trust as an essential component of building and sustaining social capital as it helps increasing cooperation. The greater the level of trust within the communities, the greater the likelihood of cooperation in which the end result all leads to enhanced trust among members or social actors. Nahapiet and Ghoshal [34] also emphasize that over time a culture of cooperation would surface among this trusted group of people, which can be strengthened through social interactions. However, this social relationship can wither if it is not maintained. Thus, interaction is a precondition for the development and maintenance of social capital [4].

P1: Trustworthiness and interactions among members involve preferences and beliefs among members for effective knowledge exchange and social capital building in VC.

P2: A high level of trust and cooperative spirit among members promotes lower transaction costs, stronger social relationships, and stronger social structure in VC.

There is also a relationship between trust and membership. Membership reflects the degree of civic engagement and the nature of horizontal relations between individuals as members who has established the necessary trust between them. Additionally, membership describes the element of cohesiveness, which is expected to exist in any social relationship. This acts as glue, which bonds the members together. McGrail et al. [32] stipulates that membership measures have not focused on membership of national organizations such as environmental groups or union because they are considered hierarchical and bureaucratic that is though as not to generate much social capital.

P3: A non-hierarchical and informal structure of VC promotes cohesive membership in order to establish a strong social and trusting relationship in social capital building.

The commitment to the community increases when people continue to volunteer [16]. Volunteerism represents selfless actions that promote community spirit and civic participation; while at the same time, changes the volunteer's self-concept to promote further volunteerism [38]. Active volunteers are those who are motivated because they perceive equitable and rewarding relationship and thus are more likely to continue their services [39]. Therefore, this act of volunteerism is a precondition to promote and sustain loyalty and commitment of the members.

P4: An active role of volunteers to facilitate and support knowledge sharing activities in VC emerges when there are elements of benefit and control in their social exchanges.

Reciprocity increases trust and refers to the simultaneous exchange of items of roughly equal value and continuous relationship of exchanges at any given time--repaid and balanced [11][41]. Furthermore, Bullen and Onyx [7] highlights that social capital is a combination of short term altruism and long term self interest as it does not only imply the immediate and formally accounted exchange of legal or business contract. The individual provides a service to others or acts for the benefit of others at a personal cost. Yet, based on general expectations of human nature, there is always a need for reciprocal acts where their kindness would be returned at some undefined time in the future. Additionally, when a community has a strong reciprocal relationship, people express their care and interest for each other more often. In turn, this relationship encourages the knowledge sharing that form the social capital.

P5: The higher reciprocal element exists among weak power members than equal and strong power members with regards to sharing of knowledge.

Only effective management and efficient role played by a leader will reduce the costs and accelerate the development of new products and services in an organization. Furthermore, organizations will need to react faster and use its resources such as social capital more efficiently in order to enhance knowledge sharing. Likewise, effective creation of knowledge sharing by the leader promotes efficient distribution of the social capital in an organization.

P6: The role of leadership facilitates the integration and distribution of knowledge sharing activities among members in order to form social capital in VC.

## 7. Conclusion

Social capital is an important resource for the sustainability of virtual communities. Virtual community provides a new platform for researchers to understand the dynamics of social networks that takes place in the virtual space. It also provides opportunities for understanding the process of social groups formation by taking into considerations the antecedents, which are expected to promote greater exchanges of knowledge and then translated as their fundamental assets such as social capital. We suggest that community can exist in both the physical as well as virtual space. We first conclude that social capital provides opportunities for societies to resolve collective problems more easily by sharing knowledge. Each member of the community accomplishes this by doing his or her share. This adds more synergistic values when people cooperate and are committed. Second, social capital facilitates communities to advance smoothly when they are bonded with trust, produce less everyday business and social transactions cost when they have repeat interactions with other fellow members of the community. Third, social capital creates enhanced awareness of the many ways in which ideas and knowledge are interlinked to develop character traits that are good for the rest of society [43].

## References

- [1] Balasubramanian, S. and Mahajan, V (2001). The economic leverage of the virtual community, *International Journal of Electronic Commerce*, Vol. 5, No. 3, pp. 103-38
- [2] Blanchard, A., & Horan, T. (2000). Virtual communities and social capital, in Eric Lesser (ed.), *Knowledge and social capital*, Woburn: Butterworth-Heinemann, p.299
- [3] Boer, N-I., van Baalen, P.J., & Kumar, K. (2002). The implications of different models of social relations for understanding knowledge sharing. *3<sup>rd</sup> European Conference on Organizational Knowledge, Learning and Capabilities (OKLC)*, Athens Laboratory of Business Administration, Athens, Greece, 5-6 April 2002.
- [4] Bourdieu, P. (1983) 'Forms of capital' in J. C. Richards (ed.) *Handbook of Theory and Research for the Sociology of Education*, New York: Greenwood Press.
- [5] Brass, D.J., & Burkhardt, M.E. (1992). Centrality and power in organizations. In Nohria N. and Eccles R.G. (Eds.) *Networks and organizations: Structure, form and action*, Boston: Harvard Business School Press.
- [6] Brown, J.S., & Duguid, P. (1991). Organizational Learning and Communities of Practice: Towards a unified view of working, learning, and innovation. *Organization Science*, 2(1), p.40-57.
- [7] Bullen, P., & Onyx, J. (1998). *Measuring social capital in five communities in NSW*. [online]. Available: <http://www.map1.com.au/A2.htm>.
- [8] Burt, R.S. (1992). *Structural Holes: The Social Structure of Competition*, Cambridge, Massachusetts: Harvard University Press.
- [9] Burnett, G. (2000). Information exchange in virtual communities: A typology. *Information Research*, 5 (4). [online]. Available: [HTTP://www.shef.ac.uk/is/publications/infres/paper82.html](http://www.shef.ac.uk/is/publications/infres/paper82.html)
- [10] Coleman, J. C. (1988). Social capital in the creation of human capital. *American Journal of Sociology*, 94, p. 95-120.
- [11] Coleman, J. C. (1990) *Foundations of Social Theory*, Cambridge, Mass: Harvard University Press.
- [12] Cohen, D. and Prusak, L. (2001) *In Good Company. How social capital makes organizations work*, Boston, MA: Harvard Business School Press.
- [13] Edelman, L.F., Bresnen, M., Newell, S., Scarbrough, H., & Swan, J. (2002). The Darker Side of Social Capital. *3<sup>rd</sup> European Conference on Organizational Knowledge, Learning and Capabilities (OKLC)*, Athens Laboratory of Business Administration, Athens, Greece, 5-6 April 2002.
- [14] Fairtlough, G. (1994). Innovation and organization, in Dogson, M. and Rothwell, R. (eds.), *The handbook of industrial innovation*, p.325-336.
- [15] Giddens, A. (1984). *The constitution of society*, University of California Press.
- [16] Ginsburg, M., & Weisband, S. (2002). Social capital and volunteerism in virtual communities: The case of the internet chess club. *Proceedings of the 35<sup>th</sup> Hawaii International Conference on System Sciences*.
- [17] Granovetter, M.S. (1982). The strength of weak ties: A network theory revisited, in P.V. Marsden, and N. Lin (Eds.), *Social structure and network analysis*, p.105-130, Beverly Hills: Sage.
- [18] Hanifan, L. J. (1916) 'The rural school community center', *Annals of the American Academy of Political and Social Science* 67: 130-138.
- [19] Hanifan, L. J. (1920) *The Community Center*, Boston: Silver Burdett.
- [20] Hiltz, S.R., & Wellman, B. (1997). Asynchronous Learning Networks as Virtual Communities. *Communications of the ACM*, p.44-49.
- [21] Hossain, L., D'Eridita, M., & Wigand, R. (2002). Towards a product process dichotomy for understanding knowledge management, sharing and transfer systems in organizations. *Submitted to Information Technology and People*.
- [22] Igbaria, M. (1999). The driving forces in the virtual society. *Communications of the ACM*, 42(12), p.64-70.
- [23] Jacobs, J. (1961). *The death and life of great American cities*, New York: Random.
- [24] Jones, S. (Ed.) (1995a). *Cybersociety: Computer-mediated communication and community*. Thousand Oaks: Sage.
- [25] Jones, S. (1995b). Understanding community in the information age. In S. Jones (Ed.) *Cybersociety: Computer-mediated communication and community* (pp. 10-35). Thousand Oaks: Sage.
- [26] Kitchin, R. (1998). *Cyberspace*. West Sussex, UK: John Wiley.
- [27] Krogh, G.V., Ichijo, K., & Nonaka, I. (2000). *Enabling knowledge creation – how to unlock the mystery of tacit knowledge and release the power of innovation*, New York: Oxford University Press.
- [28] Lapachet, J. (1995). *Virtual communities: The 90's mind altering drug and facilitator of human interaction?* Master thesis. School of Library and Information Studies, UCLA, Berkeley.
- [29] Lawrence, T. B. (1995). Power and resources in an organizational community, *Academy of Management Best Papers Proceedings*, pp. 251-255.
- [30] Lesser, E. (2000). *Leveraging social capital in organizations*, in Eric Lesser (Ed.) *Knowledge and social capital*. Boston: Butterworth-Heinemann.

- [31] Lesser, E., & Cothrel, J. (2001). Fast friends: Virtuality and social capital, *Knowledge Directions*, p. 67-79.
- [32] McGrail, K.M., Ostry, A., Salazar Thomas, V., & Sanmartin, C. (1998). *Determinants of population health: A synthesis of the literature*. Health Canada.
- [33] MITRE. (1999). *Knowledge Management: A corporate framework*. MITRE Matters Online. Available: [http://www.mitre.org/news/matters/11-99/mm\\_11-99\\_9.htm](http://www.mitre.org/news/matters/11-99/mm_11-99_9.htm)
- [34] Nahapiet, J., & Ghoshal, S. (1998). Social Capital, Intellectual Capital and the Organizational Advantage. *Academy of Management Review*, 23 (2), p.242-266.
- [35] Nelson, L., Ramsey, C. E., & Verner, C. (1960). *Community structure and change*. New York: The Macmillan Co.
- [36] Nonaka, I. (1991). The knowledge creating company. *Harvard Business Review* (November-December), p.2-9
- [37] Nonaka, I., & Takeuchi, H. (1995). The knowledge creating company: How Japanese companies create the dynamics of innovation, New York: Oxford University Press.
- [38] Omoto, A.M., & Synder, M. (2001). *Basic research and practical problems: Volunteerism and the psychology of individual and collective action*, in Wonsinska, W. et al., (Eds.), Mahwah : Lawrence Erlbaum.
- [39] Pandey, J. (1979). Social participation as a function of internal/external control of reinforcement. *Journal of Social Psychology*, 107, p.284-285.
- [40] Putnam, R.D. (1990). The prosperous community: Social capital and public life. *American prospect*, 13, p. 35-42.
- [41] Putnam, R. D. (1993). *Making democracy work: civic traditions in modern Italy*, Princeton, NJ: Princeton University Press.
- [42] Putnam, R. D. (1995) Bowling Alone: America's declining social capital. *Journal of Democracy*, 6, p.65-78.
- [43] Putnam, R. D. (2000) *Bowling Alone: The collapse and revival of American community*, New York: Simon and Schuster.
- [44] Renzi, B. (2002). Facilitating knowledge sharing through inter-action research. 3<sup>rd</sup> *European Conference on Organizational Knowledge, Learning and Capabilities (OKLC)*, Athens Laboratory of Business Administration, Athens, Greece, 5-6 April 2002.
- [45] Rheingold, H. (1993) *Virtual Communities*, Secker & Warburg, London
- [46] Rocco, E. (1998). Trust breaks down in electronic contexts but can be repaired by some initial face-to-face contact, *Proceedings of CHI '98*, New York: ACM Press.
- [47] Schuler, D. (1996). *New community networks- wired for change*. New York: Addison-Wesley.
- [48] Smith, M.K. (2001). *Social Capital*. [online]. Available: <HTTP://www.infed.org/bibliosocialcapital.htm>
- [49] Smith, M., & Kollock, P. (1997). *Communities in cyberspace: Perspectives on new forms of social organizations*. Los Angeles: University of California Press.
- [50] Stamps, D. (1998). Social capital, *Training*, Vol. 35, No. 11, pp. 44-46.
- [51] The World Bank (1999) 'What is Social Capital?', *PovertyNet*. [online]. Available: <http://www.worldbank.org/poverty/scapital/whatsc.htm>
- [52] Turoff, M. (1991). Computer-Mediated Communication Requirements for Group Support. *Journal of Organizational Computing*, 1, p. 85-113.
- [53] Walther, J.B. and Boyd, S. (1997). Attraction to Computer-Mediated Social Support. *International Communication Association Meeting in Montreal*.
- [54] Willer, D. (1999). *Network Exchange Theory (Edited)*, Westport, Cr: Praeger
- [55] Yusof, S. A. M., and Hossain, L. (2002). Towards a Social Exchange Metaphor for Social Capital Formation in Virtual Communities, Submitted to the *Journal of the American Society for Information Science and Technology*.

# Research on Role-Centric Collaborative Technology

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## Abstract

With the development of e-business, the collaboration between enterprises is increasingly strengthened, which, at the same time, challenges coordination technologies in distributed enterprise transactions. Workflow management has as its priority the support of coordination functions and workflow interoperability points the way towards collaborative business environments. Though WfMC, Workflow Management Coalition, specifies the abstract interoperability, differences such as workflow concept models, ontology etc. cannot be dealt with effectively because the specification is only technical. On the other hand, portal technology focuses on the integration of information and application services customized according to roles. It can provide support for the interoperability of workflows. In this paper, workflows are integrated with portal technology. And a role centric collaborative environment is proposed which is a way out for problems existing in workflow interoperability.

**Key words:** Role, Workflow, Interoperability, Ontology, Portal

## 1. Introduction

New economies and global markets with their accompanying intense competition have generated the need for organizations to develop and adopt new IT infrastructure to support double-win or multi-win collaborative business environments. An enterprise can hardly survive by itself facing such many global competitors. Furthermore, competitions have extended to a more macro-level, which is usually between supply chains, even value chains. In the information society environment, enterprises also need Internet technology to support their business collaboration. How to collaborate efficiently so complex business activities between organizations is a new problem facing business change management. As one of the recent IT research focuses, cross-organizational workflow technology mainly deals with the resources integration by multi-organization collaboration. It aims to establish a seamless process integration environment, to widen the business information scope, to improve the flexibility of the whole supply chain or value chain, and to ultimately improve the level of customer satisfaction.

A single organization usually cannot satisfy all customers' needs in electronic business environments, where necessary resources are highly distributive. Business organizations make great efforts to improve the quality of collaboration among suppliers, customers, and

business partners, with a view to improve their own core competence. Based on role theory, the importance of collaborative technology in Internet-enabled business environments is firstly analyzed in this paper. Then it focuses on two important potential technologies for the interoperability, i.e. portal and workflow technology. At last, a role-centric collaboration environment integrating with portal and workflow technology is proposed, which can partially solve the problem of the interoperability of cross organization processes.

## 2. Role theory basic

Role is defined as comprehensive feature abstraction of a class of entities, which can be described by common structure, behavior, property, function, tendency etc. [1] Role is used as a reasonable standard to differentiate entities for their high competence to comprehensively describe entities. The role an actor plays is not static in cross-organizational processes, because which role an actor needs to play is determined by real cases. For example, an actor in a value chain, its upstream suppliers can view it as a customer, while its downstream customers also can view it as a supplier. From a more macro view of point, a value chain is composed of a series of links between customers and suppliers. Within an organization, intra-organization processes can also be viewed as a customer chain, which links all involved departments. Customer-driven is the most popular concept in nowadays business practice, in which customers' needs are various and need to be customized. Market is getting dynamic. Traditional linear value chains have evolved into a complex, flexible, refined, and agile value-net system. Sometimes they are referred to as value networks, which are woven by value threads [2]. Organization structures tend to be networked and business operations tend to be virtual. A networked organization is usually composed of a core enterprise ,its contractors and sub-contractors. The main duty of the core enterprise is to coordinate all members of the networked organization. How to define roles of participants in a networked organization is even more complex. Usually, multi-role property needs to be assumed to a participant.

Role theory has been widely used in the access control of databases and information systems in previous researches. It is used herein to analyze the business collaboration, in order to show the importance of coordination technology. As the initiator of an activity, role is the basic component of an enterprise or a virtual organization. In process change management, role is also the main object to be reengineered. In BPR, the change

of activities and the relation between them can be viewed as the reengineering of roles and the collaboration between them. That is, process management can be seen as the analysis and adjustment of roles and their relation. Every role in the process has four basic attributes: rights, responsibilities, protocols and capabilities. When a participant acts as a role, its knowledge, capabilities and rights should meet the requirements of the role. He should also take the related responsibilities and risks, which result from his activities. The participant must act according to a special protocol, and need collaboration with other participants who take on the corresponding roles and try to complete all tasks defined by the roles within the limitation of resources, information, and rules.

From the object-oriented perspective, a role is similar to an object class, and it can be viewed as the abstraction of a class of agent objects. In system planning, roles provide templates for agents. Using roles to configure the agents can solve the problem of prematurely determining the role of a participant. Thus it can improve system flexibility to fit well with the challenge from dynamic market changes.

The formation and features of business collaboration will be further discussed from three aspects of roles, that is, competence, knowledge, and protocol.

## 2.1 Competence

According to the theory of organization competence [3], competence is the main resource of an organization, whose business scope is also decided by its competence. The core competence of an organization is the origin of its long-term competitive advantages. It includes some accumulated knowledge, especially that knowledge of how to organize processes and coordinate various participants and their different skills. This also means that an organization can be viewed as a combination of roles with various competences. Work dividing and collaboration between roles can improve individuals' competence and bring the improvement of organizational creativity. At the same time, work dividing can set up the organization boundary as a foundation for collaboration.

Organizational operations are composed of various basic activities. These activities are related to each other. Roles possess different competence to support its operations. Nowadays, a single enterprise cannot meet customers' various needs, which usually involve complex production and customized services. Businesses, therefore, need seamless collaboration and real-time interaction among R&D, suppliers, manufacturers, distributors, retailers, and customers so that the cross-organizational processes become the most important character of business operations in the e-business environment. On the other hand, enterprises can focus their resources on their core processes, and outsourcing other business operations. E-business enterprises will improve their whole competence by the collaboration and profit distribution between enterprises through the infrastructure of cross-organizational processes.

## 2.2 Knowledge

The theory of organization competence regards knowledge as the inner factors of organization competence [3]. Organizational activities need the coordination between professional individuals holding different knowledge. An organization runs as a system for knowledge integration. Its innovations are achieved by the knowledge sharing among roles.

Cross-organizational knowledge sharing brings more affluent resources of knowledge and intelligence, which will promote the technology and service innovation.

## 2.3 Collaboration

The rapid development of global economy intensifies competition among enterprises. An enterprise can hardly survive in the increasingly competitive environment without the efficient collaboration with other enterprises because its resources and competence are limited. Thus it has to focus resources on its core processes. That is to say, in order to effectively react to dynamic market changes, enterprises should concentrate on its most potential business domains, by integrating its intra- and extra-resources, outsourcing part of non-core business processes. These cross-organizational business processes aim to improve the whole competences of all member enterprises through seamless coordination.

## 3. Role-centric collaboration

### 3.1 Business collaboration

With the rapid development of electronic business, enterprises transfer their activities from traditional, direct market transactions to the whole process of value increasing, which involves the collaboration among participants on the value chain, besides the collaboration among departments and roles within enterprises. The concept of business collaboration mainly deals with the business activities and their interoperation between different enterprises. There is still no widely accepted common definition on *business collaboration*. Different definitions emphasize different scope and level of collaboration. In general, most definitions propose a well-organized combination structure of different enterprises in order to integrate suppliers, business partners, customers, and distributors on the supply chain widely into a virtual organization by Internet-enabled collaborative IT supports. Each of these member enterprises usually owns different core competence and resources. In such disparate business collaboration environments, newly emerging business models need a series of reconstruction of business collaboration structure, communication channel, and relation with customers and suppliers. The key of success of these models lay in the sharing and exchanging of information and knowledge, which are the basic needs of enterprise competence integration and coordination in this cross-organizational process management and change scenario.

In collaborative business environments, the whole supply chain or value chain becomes a collaboration system based on network and collaboration technologies.

Participants on the chain can share knowledge and information, and act in seamlessly connected cross-organizational processes, which aim to improve the response speed to customers' dynamic needs. Actually either partner enterprises, or their constitutive departments, or personnel of these enterprises can take on the collaboration roles. Such complex collaboration needs an interoperable platform to facilitate real-time information exchanges and knowledge sharing. This platform makes participants on the chain can share accurate information about their products and service in time.

Networked organizations operate through the collaboration among roles. Cross-organizational processes connect member enterprises by means of some activity points. It ensures accurate decision-making and high operation efficiency. The whole system of a networked organization can be highly effective and efficient, when roles collaborate well.

Besides those technical factors, cultural differences between collaboration partners are also very important. In some cases, the collaboration difficulty comes from partners' different business tradition. For example, some enterprises are not willing to share information with other enterprises by its traditional business practice. Furthermore, many enterprises may use different modeling methods to describe their processes, or may manage their processes in different ways. According to social psychology theory, most enterprises tend to put an enlarged importance on their own business practice, which is usually supported by their past successful experience. The difference of ontology of different enterprises brings even more challenge for designing and implementing the cross-organizational process management. Interoperability and communication between these partners having different cultural background are even difficult to be overcome both technically and culturally in these environments.

The key of successful collaborative business is the tight cooperation among roles in the form of knowledge and information sharing. Some researchers regard collaborative business as the next generation of electronic business. Electronic business model is concerned with the abstraction of roles and their relations among an enterprise, its customers, suppliers, and business partners. The flow of production, information, and capital can be clearly described in business model. One of the main research areas on collaborative business is to solve the problem of how to establish a collaborative platform for different roles with the support of Internet-based information technology. According to current technical level, cross-organizational workflows or distributed workflows are feasible solutions to this problem.

### **3.2 Cross-organizational workflow technology**

Workflow management technology is a tool for process automation and standardization. Since its first emerging in 1970's and fast development in 1990's, Workflow technology has been successfully adopted by

many enterprises of different industries. Most of these workflow application cases are limited to intra-enterprise, where it is usually applied in a relatively unified application environment or at least within a common business culture background. Although the *WfMC* (Workflow Management Coalition) has proposed a series of workflow standards, the interoperability between different *WfMSs* (workflow management systems) is limited to messaging mechanism. Sheth et al. estimate that the number of readily available workflow systems is between 200 and 300 [4]. It is nearly impossible to enforce all members in a networked organization to use a unified *WfMS*. Many enterprises use different workflow conceptual model, which is called as ontology by some researchers. This difference brings the problem of interoperability of different workflow systems used by different enterprises.

Two important collaboration technologies, i.e. the cross-organizational workflow and portal technology is discussed in this section and next section 3.3. Then, in the section 3.4, their integration is discussed. It is suggested to be a very effective support technology to cross-organizational workflow management.

Increasing customer needs on tailored service and the complexity of production process require the tight cooperation and real-time interaction between roles of R&D, Suppliers, manufacturers, distributors, retailers, and consumers. These activities need corresponding cross-organizational processes for role coordination and some standardization prescription on communication and interface protocols. More and more business processes become cross-organizational. The main research purpose of cross-organizational process management is on how to coordinate their activities in distributed and heterogeneous dynamic environments.

Cross-organizational workflows are one of the most important tools to support cooperation between roles. Current solutions for cross-organizational process coordination are mainly dependent on the interoperability of workflows. While different enterprises usually have their own organization structure, business practice, and their special ontology, the workflow integration sometimes becomes very intractable. Ontology describes basic concepts and their relation in a domain. It acts as intermediary for knowledge integration, sharing, communication and abstraction, usually domain dependent. One of the solutions for the discrepancy between enterprises' ontology is to comply with a unified ontology for all members. But this solution is too expensive to be put into practice, especially for those large-scale networked organizations, which usually have invested in a great volume of legacy systems. Another more feasible solution is to define a high level common ontology, which is changed into all members' local ontology and vice versa. Using this method, the information senders packet data and information according to the common ontology; then the information receivers decode the package in the form of common ontology into their own ontology. The transformation rules for different ontology is a valuable area for further

research. In the area of information and knowledge sharing among different roles, our recent research has conducted on how to use high-level ontology as a commonly understandable and acceptable term set for cross-organizational process communication between different enterprises.

Cross-organizational process research originates from the increasing needs for the cooperation between different enterprises. The most popular form of this cooperation is outsourcing, which is usually contract-based. Besides its legal meaning, contract is also one of the main ways to abstract cross-organizational process interaction, which includes most ontology of cross-organizational activities, such as searching for partners, interconnecting related workflows, controlling outsourced workflows, sharing workflows, etc [5]. It is a relatively practical way to solve the problem of heterogeneous ontology. One of the European Esprit FP4 program, CrossFlow [6] carries a deep research on contract-based cross-organizational workflow coordination standard and its basic structure, which becomes a candidate standard of WfMC. Contract is regarded as a common understandable describing language for cross-organizational process and process interoperation. Either WfMC standards or XML (Extensible Markup Language) can be used as the describing language for contract making and enactment. The main task of workflow interaction is to transfer right information to right participants in right time. The shortage of information sharing usually results in weak interoperability of cross-organizational workflows. Fortunately, it can be partially solved by portal technology.

### 3.3 Portal technology

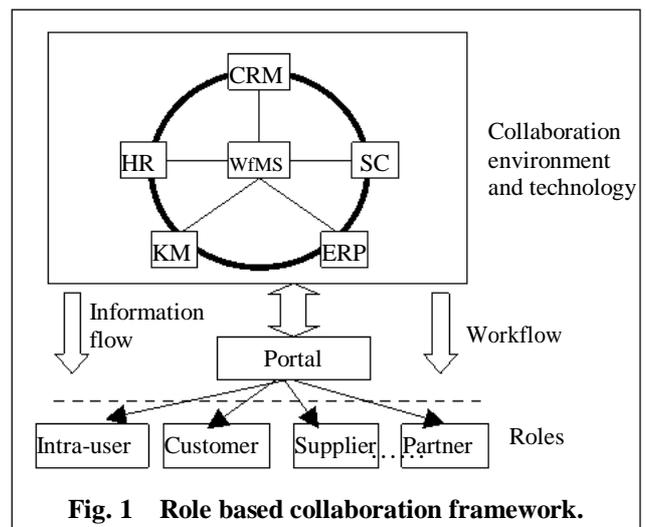
Some problems, such as drowning in data but starving for information, lack of personalized information service, and lack of proper information consistency by dynamic data association, all result in difficulties of the interoperability of cross-organizational process. It need a competent and consistent collaboration platform to provide inter-organizational information exchange service and workflow interoperability for different business roles. From a technical viewpoint, collaboration platform is a dynamic cooperation environment for dynamic information exchange between enterprises. It can be used as a basic integration framework for information and services.

As an Enterprise collaboration platform, portal can integrate many services, such as information obtaining and sharing to ensure the consistency between intra-organizational and inter-organizational collaboration. Every role can obtain all information and services from a fully personalized portal. It is an important foundation for roles to participate in collaborative activities actively.

The fundamental of portal technology is to integrate enterprises' all data resources, applications, and services by a unified information portal, which can provide personalized information and service to various

participants according to their different role, referred to as role-based access control. This information sharing mechanism also involves some security and customized service applications to provide services to all participants such as customers, suppliers, and business partners.

Portal also provides a unified access interface between users and integrated functional systems and various cross-functional applications. Enterprise portal usually consists of a unified interface and various information or service resources. Users consist of intra-organizational employees, customers, suppliers, and business partners. They can obtain information searching service through the interface. This portal-based method of information integration offers clear and unified resources for decision-making by providing a whole view of all information within an enterprise or a networked organization. The portal technology integrates existing legacy systems such as ERP, EC (electronic commerce), SCM (supply chain management), CRM (customer relation management), and HRM (human resource management), KM (knowledge management) systems etc., for all intra- and extra- participants. A true portal can act as the workflow management infrastructure for information exchange and business process interoperation. See Figure 1.



**Fig. 1 Role based collaboration framework.**

Intra-organizational employees, customers, suppliers, can effectively collaborate on different levels, such as employee-to-employee, department-to-department, and enterprise-to-enterprise, through customized portal services. Nowadays, most of enterprise information are distributed, various and vast. All these features bring the difficulty to get proper, consistent, and accurate information in time. The portal technology provides a solution by integrating different data sources and presents information in a unified, clear, and understandable form to participants according to their current roles [7]. Thus it can effectively support decision-making and improve work efficiency. The main characteristics of the portal technology are discussed as following.

#### z Role-based technology

Different participants need diverse information,

applications, and interfaces to support their activities. The role a participant plays can be changed in different business circumstances. Portal should be able to change their service portfolios according to participants' roles. The introduction of role theory to portal technology aims to simplify personalized portal service management. Role-based portal technology can provide more enough information to participants in need, with personalized interface and service portfolios, as well as access authority.

Different roles obtain content information in their personal ways. Portal designers need to analyze business scenarios and abstract types of roles. Usually there are three main types, i.e. intra-organizational users, customers, suppliers and business partners. Every type can be further divided into sub-types. Portal is not only the integrating point of applications and services, but also an environment for describing roles' responsibility. Roles can access intra- and extra-enterprise data on the basis of their authority through portal, which operates as an information intermediary. Take the CRM system as an example, CRM system integrates customers into R&D, manufacturing, marketing, and service management. Thus it can provide an effective and efficient way to manage existing customers, potential customers, and business partners. The portal system offers an information-exchanging channel for customers, distributors, retailers, suppliers, and intra-organizational users. The integrated portal service also can provide channels for cross-organizational process interaction. For example, marketing personnel can access customer information to have customized service portfolios for customers and other extra-organizational users. Marketing personnel can also use portal technology to provide differentiated production and price lists to distinct types of customers or retailers. Intra-organizational users can also access knowledge base through the portal to get necessary knowledge. The portal services can be dynamically adjusted in order to fit for each user's knowledge accumulation process. It provides a knowledge management platform especially for learning organization.

#### **z Integrating both content and functions**

Portal technology is characterized by flexibility and openness. It can collect many forms of information, such as XML, HTML, JAVA and other proprietary forms, from distributed network, to provide tailored information services. With the help of web technology, information association is achieved. For example, when an information point is found, all related information could be tracked by hyperlinks.

A true portal should create a full service collaboration environment, which integrates all applications and the applications can be dynamically connected according to users' changing needs. By virtue of portal, roles can obtain intra- and extra- enterprise information and functional supports, which can be used to facilitate workflow coordination. Thus the value of portal is fully realized. Portal is not only the interface between

application and service, but also the interaction window between roles. From the perspective of role theory, workflows can be viewed as a series of interaction between roles. This property just coincides with the function of portal. So, portal can be regarded as an intermediary for workflow interoperation. For example, in the process of production designing, all participants can exchange information through portal, to realize a concurrent designing process, which usually involves different departments or organizations.

Portal technology can integrate with other enterprise applications, such as CRM, SCM, KM systems, etc., to improve the quality of decision-making and collaboration. Portal is also based on collaboration management theory. As a collaborative support platform, portal enables a strong association among integrated function into its portal logic, which suits well with collaborative work in present business environments.

Collaborative support platform breaks down the boundary between enterprises in order to send right information to right participants in right time. Every role's tailored portal service usually involves a variety of distributed applications. A cross-organizational workflow also involves collaboration of different roles from many organizations. So it may need long time to establish the final collaboration environment by various forms of cooperation. In general, an enterprise on the value chain establishes its own applications, which are related to its workflow activities, according to the role it play in the chain. Then portal integrates these distributed applications. This solution evolves from the traditional intra-organizational integration, such as EEP, to a total integration of both intra-organizational and inter-organizational applications, which is based on some new technology standards, such as XML.

#### **3.4 Integrating portal with cross-organizational workflow technology**

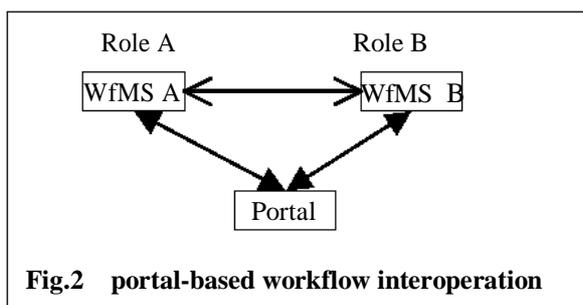
WfMS is a groupware to support collaboration between different roles involved in workflows. Currently, most existing WfMSs mainly use activity lists and alarm mechanism to support roles' activity during workflow processes, but they are lack of the ability to support role-based access control over information from different participants. Customers, suppliers, business partners apply different ontology, which is difficult to be unified, since they use different conception models, especially in the case of cross-organizational processes. The interpretability of current WfMSs is only technical, which results in the difficulty of knowledge sharing between different participants. As discussed in 3.3, portal technology can support cross-organizational workflow management. Workflow technology is complementary to portal technology. The integration of workflow technology with portal technology can improve participants' work efficiency as well as effective communication. Portal technology can work as an integrator to provide comprehensive activity lists by decomposing and re-compounding distributed activity

lists induced from different systems. Thus, roles can allocate proper resources and time for activities according to their priority.

The interoperability of traditional workflows usually has recourse to a messaging-based method by the mechanism of request and response. It only supports simple workflow interoperation, while portal technology is more versatile, that it can deal with more complex workflow interoperation. As illustrated in figure 1, WfMS is the center of the business collaboration system. It works as a neural system, which links all participants and their systems. WfMS transfers all tasks to personalized portal of every participant. By role based access mechanism, all intra-organizational users, suppliers, customers, distributors, business partners, can be integrated into E-business processes, where participants can exchange information for seamless process interoperation.

In general, the portal technology can integrate with workflow technology at least in the following three ways:

- z Portal provides customized function and information support. It sets different access priority for different roles.
- z Workflows can be used in portal technology [8]. For example, Peoplesoft co. designs portal as a hub-and-spoke WfMS integrator by the XML-based application messaging mechanism. It can integrate different WfMSs and other systems, providing comprehensive lists of activities allotted to participants so that they can properly allocate resource and time to activities, according to their importance.
- z Portal can be used as an intermediary for the interoperation of different WfMSs. As a collaboration support module, portal can also called by WfMSs as illustrated in Figure 2. This partially solves the



problem of direct interoperation between different workflows. In agent-enhanced workflow architecture, the interoperation of cross-organizational workflows is supported by the broker mechanism, which mainly deals with the bilateral ontology translation [9]. In this sense, portal can be regarded as an extended broker, which provides more affluent supports in addition to information transformation.

#### 4. Conclusion

With the development of E-business, one of the most competitive business strategies is to form alliance among enterprises according to their special core competence.

The collaboration between alliance partners usually involves many cross-organizational processes, which break down traditional enterprise boundary. It results in the urgent need of a new collaboration environment to fit for cross-organizational interoperation, especially in strongly coupled cases. Improving the workflow interoperability is one of the main tasks for this challenge. In doing so, WfMC has published some specifications on the issue of workflow interoperability.

Due to the technical limitations of current process modeling and management, as well as workflow technology in its fancy, it is still difficult to effectively deal with the interoperability problem, which also results from the difference between heterogeneous workflows and their ontology. Some distributed WfMSs are still under experiment. The key to solve the interoperability of cross-organizational processes is to design an effective method for information sharing and distribution. Fortunately, portal technology provides a partial solution as an effective tool for workflow interoperability with its customerized service portfolios according to the need of roles. At last, the integration of portal technology with workflows is proposed. It is a feasible solution for building up cross-organizational workflow collaboration.

Future research will focus on developing a prototype system to demonstrate the ideas.

#### References

- [1]Yuan Xiao-Dong, Chen Jia-Jun, Zheng Guo-Liang. "Subtype Relation Based on Role Classification" [J]. Journal of Computer Research & Development, 1997,vol34 (11): 822-827. (in Chinese)
- [2] Peter Fingar, Ronald Aronica. *The death of "e" and the birth of the real new economy* [M]. Meghan-Kiffer Press, Tempa, Florida, USA, 2001
- [3]Yu Yi-Hong. "Enterprise Nature: A New theoretical decipherment from the perspective of Competence Theory" [J]. Economic Science, June 2001: 88-95. (in Chinese)
- [4]Sheth, A.P., W.v.d. Aalst, and I.B. Arpinar, "Processes Driving the Networked Economy". IEEE Concurrency, 1999. 7(3): 18-31.
- [5]Koetsier M. Grefen P, Vonk J. "Contracts for Cross-Organizational Workflow Management" [C]. Proceedings 1st International Conference on Electronic Commerce and Web Technologies, London, UK, 2000: 110-121
- [6]Paul Grefen, Karl Aberer, Yigal Hoffner & Heiko Ludwig, "CrossFlow: Cross-Organizational Workflow Management in Dynamic Virtual Enterprises" Available at: <http://www.ub.utwente.nl/webdocs/ctit/1/0000001f.pdf>
- [7] *The Portal Technology of PeopleSoft 8: An enterprise portal platform* [R]. PeopleSoft White Paper, 2000
- [8]Joshua Greenbaum. *PeopleSoft and Enterprise collaboration: A people - centric approach to collaborative E-business*[R]. Available at: [http://www.peoplesoft.com/media/en/pdf/collaboration\\_wp\\_8\\_16.pdf](http://www.peoplesoft.com/media/en/pdf/collaboration_wp_8_16.pdf)
- [9] Shepherdson J W, Thompson S G, Odgers B R. "Cross organizational workflow coordinated by software agents" [C]. Workshop on Workflow Interoperability at the International Conference on Work Activity Co-ordination and Collaboration (WACC'99). Available at: [http://webster.info.bt.co.uk/details/grouppgs/ibsr/internal/papers/aew/waccWSPosition\\_1.html](http://webster.info.bt.co.uk/details/grouppgs/ibsr/internal/papers/aew/waccWSPosition_1.html)

# Perceived Importance of Success Factors of Firms Practicing E-Logistics in Supply Chain: An Exploratory Study on Extranet

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## Abstract

One way to enhance the success of supply chain is through the adoption of e-logistics. Much literature discuss the success stories of supply chain, it is however lacked of the determination of its success factors in the e-logistics environment. Extranet is considered as an enabler/system that could enrich the betterment of service quality in e-logistics. This paper identifies four success factors influencing to the success of Extranet; namely the quality of system, information, service and work performance. Furthermore, the analysis on its significant decision variables in each success factor through the concept of SERVQUAL is also presented.

## 1. Introduction

Traditionally, the focus of supply chain was on connection, transaction, and delivery. In today's faster-paced markets, the focus has shifted to meet market demands rapidly, correctly, and profitably. With materials flowing downstream from suppliers, manufacturers, warehouses, stores to customers and information flowing in both directions, supply chain must maintain and sustain technology-based and quality-driven capabilities in order to minimize systemwide costs, reduce lead time and transit time, and improve customer service levels. To this end, supply chain must be managed effectively. Thus, it reveals in many supply chain literature that the focus of quality-based paradigm has also shifted from the traditional company-centered setting to complete supply chain system with the implementation of e-logistics [3]. This phenomenon is especially true for the Hong Kong environment whereby it is highly critical competitive advantage of being to access the low cost production capabilities in China [5]. The adoption of e-logistics in supply chain in a form of Extranet (External Intranet), such as e-fulfillment, is a mean to which most companies seeking it as an enabler to enrich their betterment of service quality with their customers or trading partners.

Extranet is an extension version of Intranet application that applying Web technologies on the public Internet, but restricts access to a group of registered users only. With the extensive use of Extranet in the B-B environment, registered customers could gain a better understanding on the need of demand and supply of the procurement or

operations events with their trading partners. Most Extranet systems made available in the supply chain environment may also enhance the three basic functions of Intranets including (1) to create internal bulletin board that publishes information electronically, (2) to establish a distribution platform that enhances information exchanges between partners, and (3) to support daily business functions such as decision-making and training. The study of success factors and its quality of services in Intranet is plentiful in literature, such as Lai [4]. However, the success factors that influencing the Extranet has not been properly addressed in literature.

The objective of this paper is thus to remedy this deficiency by studying the success factors of Extranet in the supply chain. This paper proposes to firstly identify a set of decision variables from relevant literature and then collect data to determine its success factors. This paper adopts the exploratory factor analysis method to determine its success factors. In next section, this paper will first present the study design and measures, and then follow with the results, discussion and conclusion of our findings.

## 2. Study Design and Measures

### 2.1 Data Collection Procedure

A structured questionnaire with a cover letter was used to collect data through direct e-mails and telephone interviews. The method of telephone interview was to follow to those respondents who did not reply within four weeks after the mails were sent. 380 respondents were randomly selected from the URL homepage of <http://www.tdctrade.com>. This database is selected mainly because it provides a comprehensive web database that consists of companies adopting e-logistics and Extranet systems after the phone-calls confirmation. A total of 105 participated, with 2 incomplete questionnaires were discarded from the returned mails. Therefore, a total of 103 questionnaires was used for the data analysis, which constitutes of response rate of 27.6%. The average working experience with Extranet of our respondents was reported as 2.95 years with standard deviation of 0.51 year. Participants have been with the present company for

average of 5.46 years. These information show that the participants are conversant with the Extranet in their company. Our participants are from the industries of delivery services (including air cargo services), freight, transportation, wholesalers, trading, and logistics firms. All of our participants are presently holding a managerial position.

## 2.2 Data Analysis

This paper adopted the following methods for data analysis:

- 1) Construct validity. This paper adopted KMO (Kaiser-Meyer-Olkin) values to measure the adequacy of the samples. KMO values are typically used to judge if a group of decision variables is suitable for analyzing as the success factors when the exploration factor analysis method is used. The KMO value of 0.5 is considered to be acceptable condition.
- 2) Reliability test. This paper adopted internal consistency method to test if a set of decision variables in a cluster is homogeneous. A reliability coefficient  $\lambda \geq 0.6$  in a cluster is considered as sufficient condition to conclude a high consistency of decision variables.
- 3) Exploratory factor analysis. A general guideline is that a value of factor loading  $\geq \pm 0.5$  for a decision variable is considered as practically and significantly contribution to that factor.
- 4) SERVQUAL measure. This paper adopted the SERVQUAL measure Kettinger and Choong [2]. The service quality of Extranet can be measured by computing firstly Extranet perceptual scores by subtracting values of Extranet Performance scores of the company from scores collected from their customers. Gap correlation is then obtained by studying the correlation of Extranet Perceptual scores with the Overall Extranet User Satisfaction scores.

## 2.3 Measures

Compiling a list of relevant decision variables is firstly needed in prior to the determination of success factors for the Extranet in e-logistics. However, it is indisputable that its relevant literature is limited. In such, this paper proposes to concentrate and identify its relevant decision variables that frequently addressed in the Intranet literature. This approach is justified mainly because both these two systems share many similar features. In total, a total of eighteen decision variables that are commonly applied to Extranet environment are identified and they are: X1 = The system maintains consistently and regularly, X2= The system provides user-menu/instructions, X3= The system enhances the collaboration among group members, X4= The systems produces accurate search results/information, X5= The system gives a standardized display format (screen layout), X6= The system adopts Data security/privacy, X7= The system improves personal productivity, X8= The organization provides technical

support competently, X9= The system improves the business communication, X10= The system enhances fast response time, X11= The system provides standardized retrieval procedure, X12= The organization provides training, X13= The system provides most up-to-date information, X14= The system provides standardized search procedure, X15= The system eases to use, X16= The system improves the quality of decision-making, X17= The system helps to make decision faster, and X18= The system allows faster exchange of information.

These eighteen decision variables are used to develop two sets of questionnaire. The first set is to ask participants to evaluate their expected performance of their Extranet system in a measurement scale 1 to 5; where a value 5 represents as most important one, and value 1 as least important one. The second measurement is to ask their customers/trading partners to rate the actual Extranet performance based on the criterion of each decision variable, in a measurement scale of 1 to 5; where a value 5 represents strongly agree, a value 1 as strong disagree. In addition, we also adopted three questions to ask their customers/trading partners to evaluate the overall satisfactory of the Extranet system in a measurement scale of 1 to 5, with value 5 as excellent, and value 1 as poor performance. These three questions are used to performance the correlation described in the SERVQUAL measurement. These three questions are adopted with modification from the paper of Chow and Lui [1]. In the questionnaire, we also asked participants to consider the term "The system" be treated as "The Extranet system" and that they could consider e-fulfillment system adopted in their company is an example for such a system in the e-logistics environment.

## 3. Results and Discussions

Table 1 shows the result findings of our proposed study of success factors for the Extranet. In this table, there are three information included in each row of column one, namely labels of the success factor for the Extranet, reliability values  $\lambda$ , and KMO values. Column 2 represents the coded decision variables shown in the above section. Column 3 is the factor loadings of each decision variable. Expected and actual performance of Extranet are shown in columns 4 and 5. Perceptual performance, that is (expected performance value - Actual performance value), is listed in column 6. The correlation between perceptual performance of Extranet with overall Extranet user satisfaction is shown in the last column.

In column one, all KMO values are great then 0.5. It is therefore concluded that samples adopted in this study have reached to a sufficient condition to perform further analysis. Similarly, all reliability values  $\lambda \geq 0.6$ , and thus it shown that that decision variables included in each grouping is highly consistent. In analyzing factor loadings within each grouping, column 3 shows that all factor loadings  $\geq \pm 0.5$ , which implied that each decision

variable is significantly and practically contributed to each grouping. All expectation values in the above table have values great than 3, which implied that all these decision variables are significantly important to the success of Extranet. The perceptual scores are all negative values, which indicated that the performance of Extranet does not match perfectly with their customers' expectation.

In the last column, values with "\*" or "\*\*" representing decision variables that are considered as good potential indicators to the overall Extranet satisfaction. However, one must clear that those remaining ones do not representing insignificant to the contribution on the success of Extranet.

There are four success factors that contributing as success factors of Extranet. The first one is system quality. Decision variables related to this success factor are X2 = The system provides user-menu/instructions, X6= The systems adopts data security/privacy, X10 = The system enhances fast response time, X11 = The system provides standardized retrieval procedure, and X14 = The systems provides standardized search procedure, and X15 = The system eases to use. Second success factor of Extranet is information quality, which consists decision variables of X4 = The system produces accurate search results/information, X5 = The system gives a standardized display format (screen layout), and X13 = The system provides most up-to-date information. Third success factor is service quality. Decision variables are X1 = The system maintains consistently and regularly maintained, X8 = The organization provides technical support competently, and X12 = The organization provides training. Forth success factor is work performance quality. The corresponding decision variables are X3 = The system enhances the collaboration among group members, X7 = The system improves personal productivity, X9 = The system improves the business communication, X16 = The system improves the quality of decision-making, X17 = The system helps to make decision faster, and X18 = The system allows faster exchange of information. These four success factors are crucial and needed to be carefully considered when launching an Extranet system in the e-Business environment.

In analyzing the indicators of overall Extranet user satisfaction, four decision variables are significant in system quality success factor. These four decision variables are X10 = The system enhances fast response time, X11 = The system provides standardized retrieval procedure, X14 = The system provides standardized search procedure, and X15 = The system eases to use. In information quality success factor, two indicators of overall Extranet user satisfaction are X4 = The system produces accurate search results/information, X5 = The

system gives a standardized display format (screen layout). However, there is only one good indicator in service quality success factor, namely, X8 = The organization provides technical support competently. At last, there are three good indicators can be identified in work performance quality. They are X9 = The system improves the business communication, X17 = The system helps to make decision faster, and X18 = The system allows faster exchange of information.

Organizations should emphasize on these decision variables so that the overall user satisfaction of Extranet can further be enhanced.

#### 4. Conclusion

This paper has two contributions. First, it has identified four success factors of Extranet in e-logistics. These four success factors are system quality, information quality, service quality, and work performance quality. Second, it has determined a set of good indicators to enhance the overall user satisfaction on Extranet. A total of 10 decision variables are identified as good indicators. These indicators are 1) fast response time is enhanced, 2) Extranet system is easy to use, 3) search procedure is standardized, 4) retrieval procedure is standardized, 5) display format (screen layout) is standardized, 6) search results are accurate, 7) system support staff are technical competence. 8) Extranet system allows faster exchange of information, 9) Extranet system improves the business communication, and 10) Extranet system helps to make decision faster.

#### References

- [1] Chow, W.S, and Lui, K.H., "Discriminating factors of information systems function performance in Hong Kong firms practicing TQM," *International Journal of Operations and Production Management*, 2001, 21(5/6), 749-771.
- [2] Kettinger, W.J. and Choong, C.C., "Pragmatic perspectives on the measurement of information systems service quality", *MIS Quarterly*, 21(2), 223-240, 1997.
- [3] Kuei, C.H., Madu, C.N., Lin, C.H., Chow, W.S., "Developing Supply Chain Strategies Based on The Survey of Supply Chain Quality and Technology Management", to appear in *International Journal of Quality and Reliability Management*, 2002.
- [4] Lai, S.V., "Intraorganizational communication with Intranets", *Communications of the ACM*, July, 2001, 44(7), 95-100.
- [5] Wong, A., Tjosvold, D., Wong, W.Y.L., and Liu, C.K., "Relationship for quality improvement in the Hong Kong-China supply chain", *The International Journal of Quality and Reliability Management*, 1999, 16(1), 24-41.

**Table 1: Result findings**

	D.V.	Factor Loadings	Expected Performance		Actual Performance		Perceptual Score		Gap Correlation
			X	$\sigma$	X	$\sigma$	X	$\sigma$	
System Quality $\lambda=0.7601$ KMO=0.76	X6	0.771	4.08	1.09	3.30	0.89	-0.78	1.12	0.133
	X11	0.754	3.72	1.02	3.17	0.97	-0.54	1.17	0.287*
	X14	0.716	3.93	0.94	3.18	1.06	-0.75	1.27	0.482*
	X10	0.642	4.33	0.83	3.24	1.02	-1.09	1.25	0.305*
	X15	0.642	4.19	0.88	3.57	1.02	-0.62	1.00	0.259*
	X2	0.590	3.60	1.30	2.50	1.24	-1.10	1.55	0.097
Information Quality $\lambda=0.7125$ KMO=0.72	X13	0.904	4.33	0.94	3.41	0.94	-0.92	1.22	0.063
	X4	0.880	4.19	0.99	3.30	1.04	-0.89	1.07	0.194**
	X5	0.607	3.48	1.06	3.09	1.03	-0.39	1.21	0.267*
Service Quality $\lambda=0.6622$ KMO=0.63	X1	0.835	4.03	1.09	3.11	0.88	-0.92	1.28	0.092
	X8	0.771	4.21	0.85	3.21	0.96	-1.00	1.26	0.219**
	X12	0.729	3.77	1.05	2.56	0.97	-1.20	1.40	0.117
Work performance quality $\lambda=0.8504$ KMO=0.76	X9	0.813	4.10	0.94	3.35	1.08	-0.75	1.25	0.201**
	X17	0.791	3.74	0.96	2.86	1.08	-0.87	1.27	0.267*
	X16	0.776	3.60	1.10	2.81	0.94	-0.80	1.29	0.173
	X3	0.758	3.90	0.94	2.95	0.99	-0.95	1.21	0.138
	X7	0.708	3.95	0.97	2.95	0.86	-1.00	1.16	0.142
	X18	0.696	4.11	0.96	3.46	1.06	-0.65	1.09	0.371*

Where \*  $\rho \leq 0.05$  and \*\*  $\rho \leq 0.01$

# Collaborative Integration between IT Industry and Logistics Industry in Taiwan: A Case Study on T Company's E Logistics Plan

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## Abstract

The IT industry is Taiwan's most thoroughly globalized industry. In the IT industry, suppliers and customers are spread all over the world, so making logistics management more efficient is very important. With government's sponsorship, Taiwan's IT industry has introduced e-Procurement (Plans A and B) to make the whole procurement process among enterprises an electronic one. Thus e-Procurement became the fundamentals of e-SCM. In order to extend the benefits of e-procurement, Taiwan government continuously promote the IT industry to introduce e-Logistics (Plan D).

The objectives of this paper are to study the collaborative integration between IT industry and logistics industry in Taiwan, and to investigate the progress of introducing e-Logistics into the IT industry. A PC manufacturer, T Company was selected for use in the case study. It was found that the logistics visibility elevation through "Track and Trace" and the achievement of VMI (Vendor Managed Inventory) are the objectives of e-Logistics implementation. IT manufacturers worked out common business models. Then each supply chain can follow the common specification and implement their e-Logistics individually. This study found that not only the IT manufacturers gain the competitive advantages, but LSPs (Logistics service providers) also learn from collaborative commerce and provide better service for customers with the implementation of e-Logistics. Then eight guidelines were induced as the reference for other industries to implement e-Logistics afterward. Besides, some suggestions were proposed to IT industry, logistics industry, and government.

## 1. Introduction

Business nowadays is moving toward globalization due to the specialization and convenience of traffic channels. Recently, the booming of the Internet and other modern communication devices further serve to speed up globalization. Enterprises in Taiwan inevitably move toward global arrangements due to the limited territory and few natural resources of the country. In particular, Taiwan's companies, which are famous worldwide for manufacturing and focus on ODM and OEM, are forced to use resource from other regions to develop their products. The IT industry is now faced with not only volatile customer demands, but also a series of challenges, such as intense global competition, shortened product life cycle

and delivery, and difficult global coordination between sources of raw materials and manufacturing, this situation takes the supply network a great deal of time to integrate. Due to the time pressures caused by the vast supply network, enterprises must develop an integrated process management system to efficiently respond to fast changes within the commercial cycle.

With government's sponsorship, Taiwan's IT industry has introduced e-Procurement (Plan A and Plan B of IT applications promotion project), to make the whole procurement process between enterprises an electronic one. In order to extend the benefits of e-Procurement, Taiwan government continuously promotes the IT industry to introduce e-Logistics (Plan D). Helping more than 15 industry systems to introduce e-Logistics is the target of Plan D. Logistics costs account for 10% an enterprise's total cost[1]. The more globalized industry, the more logistics costs. So the e-Logistics plan aims to apply information technology to logistics management. In addition to extend and expand benefits of e-Procurement, it is also the critical field that companies can save costs, especially for the manufacturing industry. Enterprises can build efficient response systems to reduce inventories with information. Furthermore, they can enforce the ability of global operations and logistics with e-Logistics.

## 2. Related Works

One of the objectives of supply chain management is to make information flow among participating companies in the supply chain efficient and accurate. The information technologies such as EDI (Electronic Data Interchange) and barcode system can improve the efficiency of supply chain. These technologies can secure and distribute related trading information for buyers and sellers. It makes the trading information transfer smooth. Therefore, the efficiency of business activities among manufacturers, customers, banks, and suppliers can be improved. Nowadays, EDI has been replaced with XML-based B2B application integration. The expected benefits are greater than the EDI.

### 2.1 Quick Response

"Quick Response" is a main strategy to redesign the supply chain and make the whole process a best practice. The target is to create a quick response system based on customers' requirement. It makes the suppliers and manufacturers cooperate to satisfy customers and reduce

cost. Utilizing a paperless system from the stage of production to payment, continuously input precise data to the system, and reduce data error and data miss that can realize QR.

A study in the food industry supply chain concludes that using EDI can lead the potential cost reduction annually up to US\$27 billion [2]. Further, the study foresees inventory reductions of more than 40% with the application of innovative logistics concepts. In addition, Loebbecke and Powell [3] had investigated that through an integrated transport tracking system can gain competitive advantages. They use central information data center, communications networks, and EDI to implement the system. Every party in the logistics can easily access the logistics information. The system provides savings of more than US\$24.5 million in five years. It does not account for competitive advantage through better customer service, not for additional monetary advantages, either. Actually, every transaction can save at least US\$2.5.

## 2.2 Vendor Managed Inventory

VMI (Vendor Managed Inventory) is a program of inventory management. It is a solution to forecast the requirements and replenish by mastering the sales data and the quantity of inventories. Suppliers can more effectively response to the changes of market and requirements of customers. Thus VMI can reduce the inventories, increase inventory turnover rate, and then maintain the appropriate quantity of inventory. Because manufacturers share important information with suppliers, both of them can improve requirement forecast plan, replenishment plan, transportation and shipment plan, and so on. VMI is changed from traditional replenishment according to purchase orders to replenishment according to actual consumption and forecast. Therefore, VMI model is well suited the dynamic business environment today.

There were many real practices in American, such as Wal-Mart, Campbell Soup, Johnson and Johnson, and Procter and Gamble [4]. They have reduced the inventory with mastering accurate consumption information.

## 3. Case Study

T Company is an IT manufacturer. It focuses on personal computer manufacturing. In addition, it is an OEM/ODM company serving major brand-name customers. Confronting both international and domestic intensive competition and challenges, T Company has deployed manufacturing factories, assembling factories, and research and service centers worldwide. In addition to headquarter in Taiwan, T Company has established factories in Thailand, Mexico, the U.S., Netherlands, the U.K., and Mainland China. And it established JIT (Just in Time) warehouse in El Paso near the boundary between the U.S. and Mexico. All of the arrangements construct the foundation of global operations and logistics.

In the past, T Company had developed the MRP

system and MRP II system to elevate the manufacturing ability. After focusing on the development of 3C business and the global operations, it introduced J. D. Edwards' ERP system successively in the U.S., Mexico, and Netherlands, to meet the major brand-name customers' information requirement and integrate all the business functions. The MRP system and the J. D. Edwards' ERP system are the backbone of the global operations network now. In the past two years, T Company had implemented e-Procurement, the fundamentals of e-SCM, under the sponsorship of the Ministry of Economic Affairs of Taiwan.

Recently, T Company is aware that focusing on manufacturing may meet some limitation in gaining competitive synergy. Therefore, it plans to provide major brand-name customers with integrated product services (IPS) that cover advanced research, product development, fast-prototyping, manufacturing, and global logistics throughout North America, Europe and Asia. Therefore, T Company applied for the sponsorship of Plan D and began to implement e-Logistics.

### 3.1 The Foundation of Taiwan IT Industry e-Alliance

Early in October 2001, the IT companies applying for government's Plan D sponsorship started establishing a users group. The shippers (IT manufacturers), LSPs (logistics service providers) and logistics information ASPs (applications service providers) were invited to join the users group. The target of Plan D users group was to hold conferences to strike out common business models and information technology infrastructure as early as possible. Members of Plan D users group have to follow the outcomes that the Plan D users group decided in deploying the business models and IT infrastructure on their corporations to enable them to do business with other companies via the common manner. After several months, Taiwan IT Industry e-Alliance was set up based on the Plan D users group.

The mission of Taiwan IT Industry e-Alliance is to develop the common specifications and the acceptance criteria for validating implementation results, and to promote the developed specifications and criteria. Members of Taiwan IT Industry e-Alliance used the scenario proposed by RosettaNet for e-Logistics as reference model and discussed how to modify it to fit all the members' need. They may add some PIPs into the scenario and take off some PIPs from the scenario. Once the modified scenario is decided, members can follow the common scenario to determine the specifications of PIPs. The last stage is to figure out IT architecture to fulfill these business processes.

### 3.2 Implement e-Logistics

T Company has confronted the following requirements in logistics management.

- z VISIBILITY (make the material flow visible)
- z OPTIMIZATION (make the material flow routes

optimal)

z MANAGEMENT (make the logistics efficient)  
Therefore, T Company proposes to implement its e-Logistics system with following core information technology.

z ASP

ASPs (Application Service Providers) are third-party entities that manage and distribute software-based services and solutions to customers across a wide area network from a central data center.

z RosettaNet

For the issues of supply chain process standard, some large information enterprises established RosettaNet organization, a nonprofit organization that strove to define the standard in IT industry supply chain management. The first target of RosettaNet is to make the standard in business processes, and the second one is to make the standard in message syntax. The RosettaNet standard is composed of PIPs, RNIF, and dictionaries. PIPs (Partner Interface Processes)[5] are specialized system-to-system XML-based dialogs that define business processes between trading partners. The RNIF (RosettaNet Implementation Framework) Core Specification provides exchange protocols for quick and efficient implementation of RosettaNet standards. Dictionaries reduce confusion in the procurement process due to each company's uniquely defined terminology.

The architecture of T Company's e-Logistics System is shown in figure 1. ASP provides a public information exchange center. T Company constructs its virtual private logistics information center under the public information exchange center. The private hub can provide logistics information for every site of T Company, including factories in Thailand, Mexico and distribution center in El Paso via the Internet. In addition, T Company's suppliers and LSPs can access information in the hub with browser or through gateway. The brand-name customers and international LSPs use the international logistics information ASP for information exchange. T Company's private hub connects with the international logistics information ASP directly or through Taiwan public logistics information hub. This makes information share among all the partners of supply chain network.

Furthermore, data gathered in the hub can be used in planning. Managers can reconcile supply with demand, and make production planning according to the status of each node in the global logistics pipeline. Thus FPS (Factory Planning Simulation) system can generate simulation reports in accordance with logistics information in the e-Logistics hub and data generated from ERP in each factory.

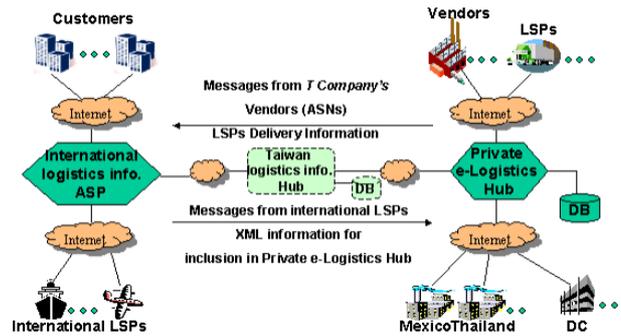


Figure 1: Architecture of T Company's e-Logistics System [6]

T Company provides three different interconnection manners for their partners as shown in figure 2. Thus its trading partners can select one way and implement their systems based on their requirements and IT ability.

z System Integration with Open Standard (Class A integration):

Companies with higher IT capability can implement RosettaNet compliant system to integrate the processes among buyers and sellers. Both messages and processes follow the common standard.

z Electronic Data Interchange through Turnkey System (Class B Integration):

Companies use this kind of integration to streamline two companies' backend ERP with document exchanging. It is similar to traditional EDI. Companies use turnkey solution that ASPs provided to achieve standard message exchange.

z Web Access (Class C Integration):

Users connect to the website that central manufacturers provided with browser. This kind of connection doesn't have system connection, and only exchange with common XML standard.

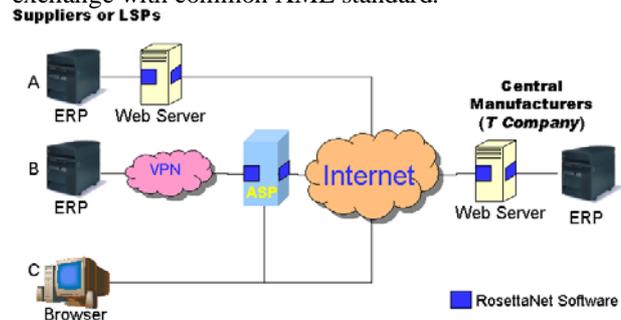


Figure 2: The Frameworks of Introducing RosettaNet Standard [7]

### 3.3 Business Process and Expected Benefits

In the logistics management, T Company still use fax, telephone, or e-mail as the media of information exchange. It is hard to master actual logistics situation, such as the quality and efficiency of logistics. The maximum synergy of e-SCM can't be achieved. T Company consequently introduces e-Logistics so as to seamless streamline the processes of all the partners in supply chain network.

The scenario illustrated below not only represents the situation that T Company meets; but also represents the situation that many other companies may meet. It is

time consuming and inefficiency.

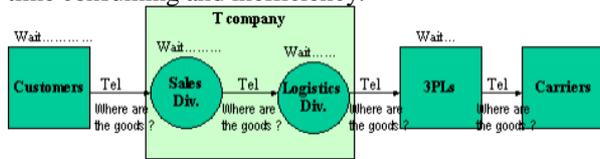


Figure 3: Original Track and Trace Process

Taiwan IT Industry e-Business Alliance had decided to use RosettaNet logistics related PIPs (Partner Interface Processes) as the common standard. Members of alliance must follow the common business processes and implement the infrastructure to exchange messages. The concluded business models including two main functions, “track & trace” and VMI (Vendor Managed Inventory). Track & trace can be further divided into two parts, shipping order management and shipment status.

Table 1: Functions and Related RosettaNet PIPs

Function		RosettaNet Partner Interface Process
Track & Trace	Shipping Order Management	PIP 3B12 Request Shipping Order PIP 3B18 Notify of Shipment Documentation PIP 3B13 Notify of Shipment Confirmation
	Shipping Status	PIP 3B3 Distribute Shipment Status
VMI (Vendor Managed Inventory)		PIP 4A2 Notify of Embedded Release Forecast PIP 4A3 Notify of Threshold Release Forecast PIP 4A5 Notify of Forecast Reply PIP 3B2 Notify of Advance Shipment PIP 4C1 Distribute Inventory Report PIP 4B2 Notify of Shipment Receipt

Source: Taiwan IT Industry e-Business Alliance, sorted by this study

#### z Track and trace

The scenario of tracking and tracing is shown in Figure 4. The supplier create shipping order request (specifies which products to ship, how to ship them, the origin and destination locations, and other related information). Then the message (PIP3B12) is sent to LSPs. The LSPs create order confirmation to reply. Suppliers create shipping notification with the shipment. Suppliers need to request LSPs to ship the components to customers whenever a sales order is received. It is required to provide delivery documentation. The LSPs inform the supplier when the shipment has been sent with PIP3B13.

Shipping status information has to be sent to the supplier or the consignee according the agreement.

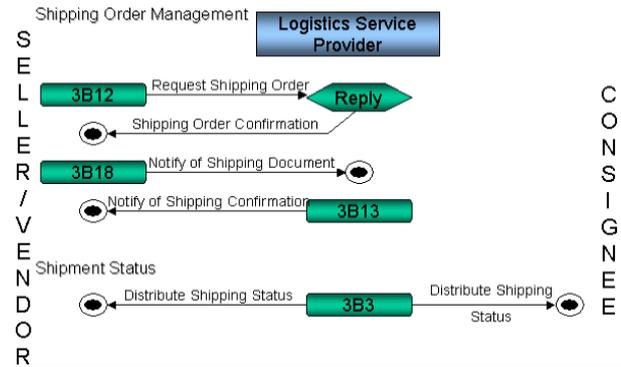


Figure 4: Trace & Track Using RosettaNet PIPs [5]

#### z Vendor Managed Inventory

The scenario of tracking and tracing is shown in Figure 5. The customer create a release forecast with product demand information (PIP4A2) or create threshold release forecast (PIP4A3) with product demand information, current product inventory levels, and target product inventory levels and send the message. The distribution center creates an inventory report to both the seller and the customer. The supplier notifies the receiver that a shipment has been assigned and created the detail Advance Shipment Notification. Then the physical distribution is conducted. When the goods enter into the distribution center, the distribution center creates a shipment receipt with receipt information. When the customer needs materials, the customer sends pull signal to the distribution center. Furthermore, the distribution center can replenish. The customer sends consumption reporting to the seller with PIP4B2.

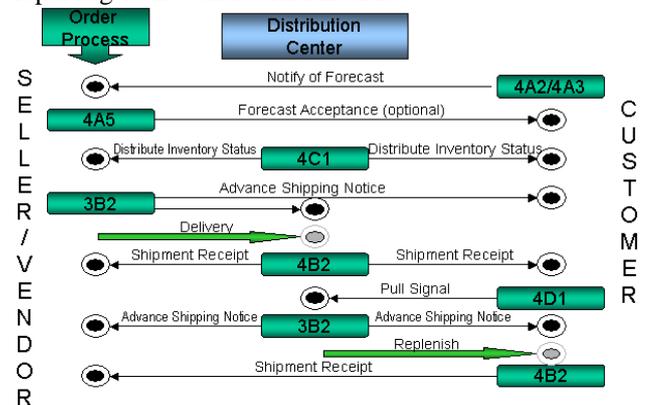


Figure 5: VMI Scenario Using RosettaNet PIPs [5]

Therefore, T Company can elevate the visibility of logistics with business automation and the operation of e-Logistics hub. And the VMI model can be achieved by automating processes.

## 4. Findings and Exemplary Effects Investigation

### 4.1 Findings

During the execution process of this plan, this study discovers that large gap exists between the scale of the logistics companies as well as their capabilities on utilizing information technology. How to lead all the

logistics companies into electronic operations would be a tough issue. It is a good way to classify the on-line connections of a system into three levels. The advantages of this classification include: 1. Provide different connection models in accordance with the different demand levels of IT ability for different users. 2. Every logistics companies can join the entirety of the e-Logistics.

Moreover, T Company also plans to help several LSPs to adopt B2BI. T Company has experience in adoption B2BI (e-procurement), and it also could impart their own experience in adopting them and sufficient orders to drive them to accept new technology, thus, the time of adoption and the possibility of failure would be reduced. For the LSPs, in addition of the orders from T Company, the introduction of new IT technology could not only enforce the IT capability but also reduce the cost and the necessary time responding the demand of the customer through this new operation.

#### 4.2 The Issues and Corresponding Measures

During the introduction of Plan B, the late launching of users group caused the progress of introduction highly delayed. Besides, they had spent a lot of cost long before the common range and standard identifying. As so, the Plan D learned the lessons. In the initiation of the plan, the enterprises form a user group. Under the discussion, they determine the specification of message exchanging, and standard. IT manufacturers and LSPs can implement e-Logistics early.

From the result of the investigation of the current industry application by Electronic Commerce Resources Center of Institute for Information Industry designated by Taiwan IT Industry e-Business Alliance; the RosetteNet has developed several scenarios. Therefore, the domestic enterprises could choose scenarios those are fitting them. It not only saves plenty time and cost but also could connect with the international enterprises directly.

From the past experience of the introduction cases and the researches that focus on KSFs (Key Success Factors) of introducing enterprise information systems[8], it can be found that the high-level managers play a very important role, especially for large-sized plans, they even could be crucial for the success or the failure.

Most of the central manufacturers that participate in the e-Logistics plan are the multi-national enterprises. Hence, the choice for designation of the domestic logistic operations which means from domestic suppliers to the domestic assemble factories or manufactories of the domestic central manufacturers is only among the domestic logistics companies, and the choice for designation of international or cross-national logistic operations is among the large-scaled international logistics companies or the international third party logistics service providers. On the opposite, the information processing and the delivery status recall still not get involved deep enough or even not established yet for our domestic logistic corporations. Probably their customers, such as the domestic IT enterprises or the

component suppliers, could check the delivery status by phone calls, but still is short of a spontaneous recall service. Few of the international logistic corporations, for example, UPS, they generally already digitalization in depth, have high cooperation attitude toward this plan and showing their determined support for the introduction of international standard – RosettaNet. Besides, they also have enough IT ability for this introduction. A large part of the logistics service providers or freight forwarders have already sensed the importance of tracking and tracing. In the past, they solved it by outsourcing the establishment of the web site for providing the requiring service but still lack of the abilities in maintenance for the continuing service. So the e-Logistics plan is very welcomed by them as long as the plan gets the support from the central manufacturers.

In general, the enterprises that participate in the plan would designate the logistic assignments to the international third party logistics service providers and they, again, outsource the practical delivery assignments to other companies, including the domestic land carriers, the international land carriers, ocean carriers, and air carriers. Those land carriers usually have not built up the tracking and tracing mechanism yet. Thus, the delivery tracking and tracing is obviously difficult and the information of the responsible department is always behind the latest one. This issue relies on the international third party LSPs to be solved.

Another issue is that the logistics industry has the controversy of the RosettaNet standard proposed by the IT industry. They thought that the standard is particularly set up based on the conditions of IT, EC and semiconductor without considering other industries. Especially, this standard does not include all required processes for the logistics industry. The practical solution is that building up a common standard inside the industry so that the only assignment for logistics corporations would be mapping when integrating the IT process. Actually, this solution should be derived from the logistics industry itself.

#### 4.3 Effects

BPR teams should be conducted simultaneously once the Plan D started in order to re-engineer the organizational structure and all business processes.

A comprehensive education and training program for this plan is essential. From real experience, it is found that many employees have defensive attitude toward the plan without fully understanding. However, this system could reduce their job load and let them put more efforts in a more meaningful duty with more additional value. For example, the traditional tracking and tracing process cost a lot of manpower. From the beginning, the customer needs the delivery status. Then, they make the phone calls to the internal purchase department; the purchase department inquires the logistics department; then, the logistics department contact with LSP; then, LSPs contact with Carrier, and so on. Under the Plan, those level-by-level inquiring could be solved at once by web site directly from the customers. The duty for the

purchase department, logistics department, etc could shift to higher value-added jobs, such as analysis.

A good communication is also necessary. This plan needs wide involvement, and the participants may contact with various departments or countries. For practical experience, unpleasant cooperation has occurred because some departments were not informed in advance. The precedent communications among all involved departments are dispensable.

#### 4.4 Exemplary Effects Investigation

The IT industry is chosen as the pilot of the B2B integration introduction by the government and thus, gains the assistance. The purpose of this pilot project is to spray the experience to other industries that would like to join the plan afterward. No matter it is success or fail, the most important function of this plan is to keep the conclusion and provide to other industries in order to avoid similar mistakes and unnecessary time-consumption in implementation. That is what we called the spirit of demonstrative "Information Technology Applications Promotion Project". Here are some findings and suggestions that may be applicable for other industries interested in introducing the similar plan in the future.

##### 1. Organize users group as early as possible

The foremost condition for a successful plan is the foundation of User Group that could provide a mutual communication mechanism together with the establishment of the relevant standard. To reach the common sense of the participants is the purpose of the users group so as to corresponding the coming of an era of group competition.

##### 2. The manufacturers drive the participation of the upstream suppliers of the supply chain and the logistics service providers

From the experience of Plans A and B, the success is owed to a key point caught by the Department of Industrial Technology of The Ministry of Economic Affairs— start from those center manufacturers of a supply chain. It just likes to hold a bunch of sweet corn. To hold the knot means to hold the whole bunches. Consequently, the Plan D follows the same model, except some of the large-scale LSPs join users group spontaneously; the center manufacturers are in charge of the drive the participation of the cooperated LSPs for the discussion and establishment of the business process and the specification of the information technology.

##### 3. Build up a common partner interface process and message standard

Standardization is still the spirit of Plan D. The implementation of the interactive dialogue of e-business and the operations process of the enterprises are possible only after standardization. The common standard that followed by all participants is on the list of the primaries in integration introductions. There are two ways to set up the standard: the first choice should be the current international standard; if not, then set up a new one according to their own by the way of imitating the current successful model such as RosettaNet, for example: its

RNIF, PIPs, Dictionaries and the methodology of the process integration is suit to be the reference for other industry. Besides, XML could be a good basic tool when set up the standard for the integration of business-to-business on the angles of its excellent self-description.

##### 4. Participate in the discussion of the international industry standard

If we analyze the past rules showing in the IT industry, we could easily found that the standard has become a weapon of these international major enterprises and caused a clear boundary between different systems. The competition start far from choosing the standard if a group of major IT corporations decide to follow some certain standard. All the relevant product is deem to follow the decision of theirs. In short, the future is a war of the standard. As far as the Taiwan domestic corporation on the position of suppliers to be concerned, lost the opportunities to participate establishment of the standard, it means to risk the possibility of the replacement. For example, the current standard, RosettaNet and Oasis etc, are dominated by foreign enterprises. Thus, they may not put our consideration on the list. The IT industry hopes that the assistance in regularizing standard and striving against the dominancy from the government could be more active. At that time, we, the suppliers, could own more negotiation power than the customers and the strength for a long-term prospect of the IT industry.

##### 5. Establish common business model and process

The principle for establishing common business model should be focus on coordinating a proper one for everybody based on the original one owned by each one. The business model could modify the process situation set up by IT industry that could reduce the necessary effort of introduction.

##### 6. Draw up the relevant IT support

For the necessary IT supporting this standard business model and process, the participants should looking for the IT corporations that fit for the process of the corporations. However, the framework proposed by the IT industry is possible a good choice, the participants afterwards might follow as well.

##### 7. Seek support from high-level managers

As we mention in the last section, the high-level managers holds crucial element in a large-scale plan.

##### 8. Implement BPR in accordance with the plan

To adopt the needs of the common business models demand great modifications in internal process so we could not neglect the importance of the internal BPR when we introduce B2BI system.

However, what kind of industry is particularly suit for this model in e-Logistics introduction? The nature is more similar to the IT industry, the more possible for the participant to adopt this plan and the less cost in modification it would need during the introduction. From the observations, among of all the industry, the auto industry is the most close to those of the IT industry. For example, the earliest application model is from the one of

the TOYOTA in the respect of JIT. We suggest that the auto manufacturers are the best choice for government for the option of popularizing the demonstrative model. The other option could be mechanical and electrical industry, flight and space mechanic industry, or the medical equipment manufacturer etc., with slide modification of the model to fit the individual needs of the industry.

## 5. Conclusions and Suggestions

### 5.1 Conclusions

The crucial point for achieving and holding the No. 1 market share in the current global business market is the speed of information integration – The faster, the better. As the information is getting visible and instant, the competition of each industry is getting serious. The only chance for the corporation to survive is rely on the ability to respond the market demand instantly and put the customer satisfaction on the top of the list.

Another important element for a successful enterprise in this era is choosing the ways of the efficient alliance, instead of standing along. Only the cooperation and pursuing the mutual beneficial of the corporations could create the best benefit for themselves, as the market in the future would be a competition of the whole supplier chain, instead of just the corporations in the past.

Plans A and B has integrated the upstream suppliers, the central manufacturers, and the downstream customers in an entirety of electronic supply chain and Plan D also has brought into the logistics industry, a kind of bridge between the enterprises, in this entirety, at the same time, the conjunction of Plan C with those two plan could form a complete integration of supply chain with “information flow”, “material flow” and “cash flow”. Then, this integrated chain definitely could increase the overall competition of our IT manufacturer industry and furthermore, drive the whole domestic industry to advance into a new boundary.

### 5.2 The suggestions for the industry

#### 1. The suggestion for the IT industry —Enforce ERP

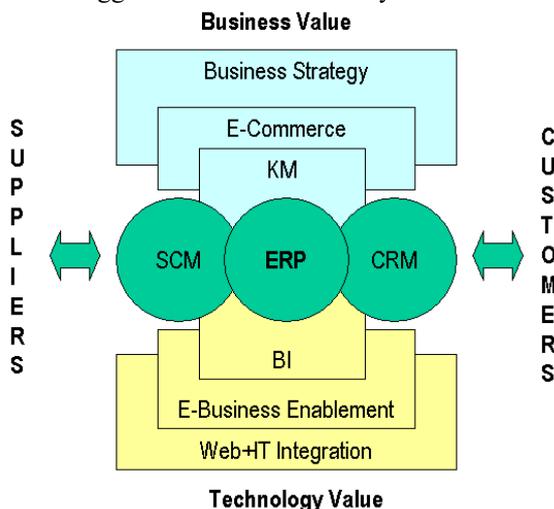


Figure 6: Malecki's view of e-Business [9]

ERP is the core for the operation of the e-Business, the pivot of all applications. Form the view of Malecki in the e-Business as shown in figure 6, we know, the most overall effect is from the coordination between the B2BI introduction and the internal IT system. The introduction of ERP develops from “the predomination of the competition”, “the necessity of the competition” to “the foundation of the competition” until now. Before introducing the business-to-business application integration, the enterprises should, first, has a robust ERP system.

#### 2. The suggestion for logistics industry

z The standardization of logistics process in accordance with the IT introduction

The IT industry has already own mature IT in internal facilities and went through the phase of rationalization. As we mentioned before, the issues should be the different depth of information processing in logistics industry. The most effect of B2BI introduction relies on the standardization of logistics industry.

z The integrations of their own IT system

During the process of introducing the Plan D, we could observed that the logistics choose passive attitude toward providing the relevant information to the IT manufacturers, that brings more convenience to the latter but more burden to the former. The logistics industry should conduct an internal system integration (Enterprise Application Integration) and enforcement in its own information system so as to connect with B2BI system by the way of automation. An overall automation is an important element for a best overall effect of the business-to-business application integration.

z Enforce the understanding of e-business

For the whole environment of e-business, the key point is the connections between upstream and downstream corporations. It will reduce the individual character of the logistics industry from the angle of pursuing the best effect of the whole supplier chain, instead of individual benefit. In the future, in addition to the demand of a fast order process and transportation, the accuracy in controlling the amount and type of the goods, the integrity of controlling the inspections, and the goal of zero stock amount and shortage are also the criterion of a standard B2B logistics service.

z Participate in relevant projects sponsored by the government

Our government also provides relevant electronic project for domestic logistics industry. The demonstrative “mobilized logistics information system” sponsored by Department of Commerce under the Ministry of Economic Affairs in 2002 is an example. The aims of this project is to drive the applications of wireless communication technology into logistics industry in accordance with the goal of business automation and e-business by helping them to introducing “mobile information technology” so as to increase the efficiency of the transportation and the utilization of the fleet, increase the service quality and decrease the transportation cost. It is a good opportunity for logistics industry to offer a better service by enforcing

its infrastructure and introducing e-Logistics.

### 5.3 The suggestions for government

This plan is expected to advance the logistics industry from the respect of IT. However, we still have several suggestions as below for the government:

#### 1. Encourage the establishment of public hub

We suggest that government could encourage the establishment of public hub by the ways of demonstrative applications system or other reward investment program.

The spirit of the public hub is: As long as you connect with the hub, you connect with numerous enterprises that join with the hub. Save the cost and increase the effect are the major advantages of this model.

Nevertheless, the participants of the Plan D has many concern and criteria and is suspect with the neutrality of any central manufacturers since the hub is a convergence owned all the details of the participants. It is possible to estimate the operation status of the participants from the information saved in the hub if someone intend to. We suggest the government assist to establish the hub under a third party with a reputation of just. Moreover, the government could offer preferential measures and for those who are willing to adopt the public hub. Besides, the public hub is not only established for IT industry but also could provide for other industries to use.

#### 2. The strategy of international logistics set by the government still has rooms for improvement

The current global strategy of our government still focuses on the manufacturers with less consideration of assistance in logistics industry. For the domestic logistics, the major concern is usually the cost. The government could lead them entering the international logistics under the special project. Besides, IT manufacturers may assistance logistics firms to enter the international logistics.

#### 3. Cross-industry integration needs Cross-industry plan

Plan D is sponsored by the Department of Industrial Technology of the Ministry of Economic Affairs; while the Department of Commerce of the Ministry of Economic Affairs and the Ministry of Transportation and Communications are jointly responsible for servicing and supporting the logistics industry. When the IT industry and the logistics industry make effort in such collaborative integration, all the responsible departments of the government should set up a joint supporting framework to provide strong assistance to the Plan participants.

#### 4. Sponsor the development of Taiwan-based R&D center and global logistics and operations center

Taiwan is a small place. In the recent, we face the pressure of industry moving outward. In the past, the development country, such as U.S.A. or Japan, has been gone through and it turns out an expansion of IT industry, instead of reduction. Besides, that the manufacturing base shift to Mainland China should be regard as a global expansion, instead of a view of industry emigration since the advantage of low-cost has disappeared in domestic environment. The assistance for the corporations in developing the Taiwan as the center of R&D and global

operation could start from the outstanding the features of our industry and product, then, cooperated the proper global operation plan of the central manufacturers of supply chain as the schedule and encourage the coordination of the satellite enterprises for the purpose of a competitive regional supply network.

### 5.4 Suggestions for Future Research

The advance of IT is at a tremendous pace. During the process of the e-Logistics, we discovered that many technologies in the applications of business are discussed enthusiastically, for example: Web Services, ebXML...etc. The relevant technology may not be mature enough but those ideals are fantastic. The progress of the IT would never stop and it is a good topic for the researcher afterwards to study.

For the logistics operations, the visibility of the material flow is only an initiation. The most important steps should be the application strategy after obtaining the visibility information. Until the research is closed, this part still remains on the paperwork without practical performance or implementation. This is also a good topic for further study.

Once Plan D is finished, whether the benefits could be achieved as expected is another potential topic for further study.

Reviewing from the e-procurement in Taiwan's IT manufacturers to the e-Logistics and e-financing after e-procurement, the trend of the future, the Plan E – engineering collaboration and the relevant knowledge management, can be peeped. Likewise, the Plan E and the relevant knowledge management are worth of future researches.

### References

- [1] Taiwan Association of Logistics Management, 2000 Logistics Yearbook of R.O.C, Ministry of Economic Affairs, December 2000.
- [2] Coopers and Lybrand, Gerstner. S, (1996) Efficient Consumer Response (ECR) No. 82, 1995.
- [3] C Loebbecke and P Powell, "Competitive Advantage from IT in Logistics: The Integrated Transport Tracking System", International Journal of Information Management. Vol. 18, No. 1, pp. 17-27, 1998.
- [4] Nolan, K., "For Marmon/Keystone, VMI Offers Real Procurement Solution", Metal Center News, pp.50-60 Feb 1997.
- [5] The web site of Rosettanet organization, <http://www.rosettanet.org>.
- [6] Case Company, internal document.
- [7] Chung-pin Liang, "Introduction to RosettaNet Express Project and Solution", Lecture hold by RosettaNet Taiwan, July 2001.
- [8] AllianceSohal, A. S. and Singh, M., "Implementing Advanced Manufacturing Technology – Factors Critical to Success" Logistics Information management, Vol.5, No.1, pp.39-46, 1992.

- [9] Malecki, M. H. III. (1999, August 30). Introduction to e-business. Paper presented at seminar on industrial e-business, Taipei.

# Impact of Information Sharing in Supply Chain Management

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## Abstract

It has been pointed out that a vital element of SCM systems is the sharing of information such as sales figures and delivery plans between multiple companies or between different divisions of a company. However, the potential benefits of SCM for individual companies that actually share information has yet to be properly investigated.

In view of this, the present study modeled company activities in a way that considered decision-making not just over the execution-level, but also over the tactics- and strategy-level. Simulation was then used to investigate the impact of information sharing on company gross profits.

In this study on supply chains in the electronics industry, we confirmed that sharing information such as product plan and procurement plan between a component manufacturer and assembly manufacturer can lead to improved gross profits for all companies involved. We demonstrated that the benefit of sharing strategy-level plans is greater than in the case of sharing execution- and tactics-level information. The increase in gross profit was seen to be particularly large in the case of declining demand. In addition, while earlier studies evaluated the impact of information sharing by looking at inventory levels, this study confirms that reducing inventory does not necessarily lead to improved gross profits, thereby highlighting the importance of gross profits as a measure for assessing the impact of information sharing.

## 1. Background and objectives

Supply Chain Management (SCM) systems for integrating and controlling entire chains of supply processes - from suppliers to manufacturers to wholesalers to retailers and through to customers - have drawn a lot of attention in recent years.

It has been pointed out that a vital element of such systems is the sharing of information such as sales figures and delivery plans between multiple companies or between different divisions of a company. However, the potential benefits (management impact) of SCM for individual companies that actually share information has yet to be properly investigated.

The present study therefore examines SCM in the electronics industry, with the aim of investigating the impact of information sharing between manufacturers.

## 2. Positioning of the study

This study focused on assembly manufacturers,

component manufacturers and parts manufacturers involved in the production of electronics goods such as personal computers, mobile phones and digital home appliances. From the results of a survey of such companies, their supply chain-related activities can be classified into the three categories listed below.

- Supply activities: How to sell/supply products
- Transform activities: How to make products
- Procurement activities: How to purchase raw materials and production capacity

Generally speaking, supply chain is the chain of those activities over company, and each company assumes demand and uses it for decision-making, exchanging or adjusting plan information between activities as shown in Fig.1. However, it has been recognized that this independent demand model is easy to cause the bullwhip effect that each demand is amplified along the upper stream of supply chain and excess inventories arise.

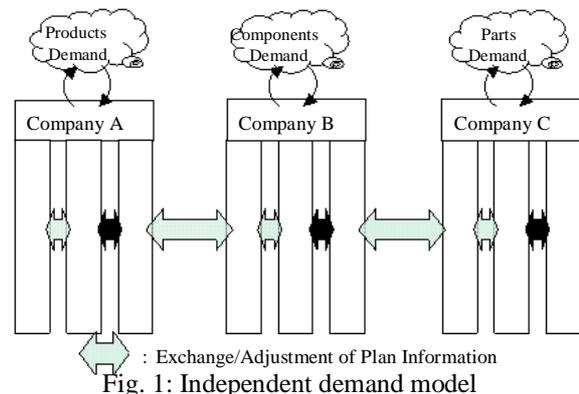


Fig. 1: Independent demand model

Some earlier studies have quantitatively analyzed the effects of information sharing in supply chains [1][2]. Most of these studies have simulated companies using simple inventory models, to forecast demand using information such as inventory on hand at preceding companies in the supply chain (e.g. for suppliers, manufacturers), sales figures and buffer inventory as shown in Fig. 2. These forecasts are then used to determine inventory replenishment levels. Thus, these studies have demonstrated how information sharing can improve inventory efficiency and eliminate lost sales opportunities.

However, these studies have examined only the benefits of information sharing (reducing inventory and lost sales opportunities) for decision-making over the execution- to tactics-level, as shown in Table 1.

They have not investigated the benefits of information sharing on tactics- to strategy-level decision-making for

determining optimum use of production resources (increasing utilization efficiency of production resources). Furthermore, they have not shown the impact of SCM on company gross profits.

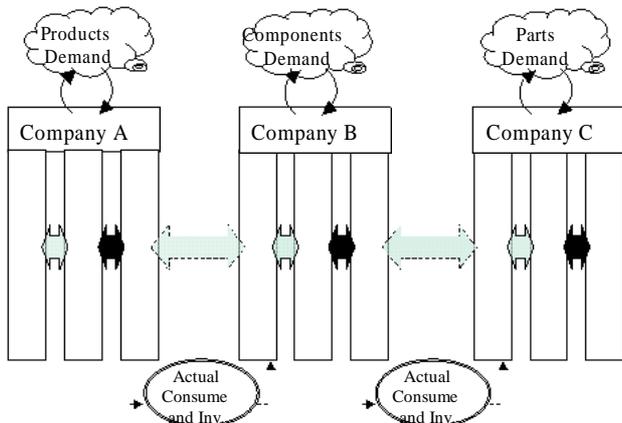


Fig. 2: Information sharing model of current SCM

Table 1: Planning level and positioning of this study

	Planning Period	Time Bucket	Planning Cycle	Aim	Effect of Info.Share
Strategy Level	6 months to Several years	Months	Monthly /yearly	Planning suitable equipment and human resources	Improved ROI
Tactics Level	1-3 months	Weeks	Weekly /monthly	Planning within the possessed resources and ensuring raw materials	Improved ROA (The rate of Operation)
Execution Level	1-14 days	Days	Daily /weekly	Planning day-to-day operations	Reduced inventory levels / loss of sales opportunities

Dependent demand model that each plan information is calculated by MRP based on the demand of the lowest reaches of the supply chain as shown in Fig. 3, is recognized as the model in which each company shares the tactics- to strategy-level information.

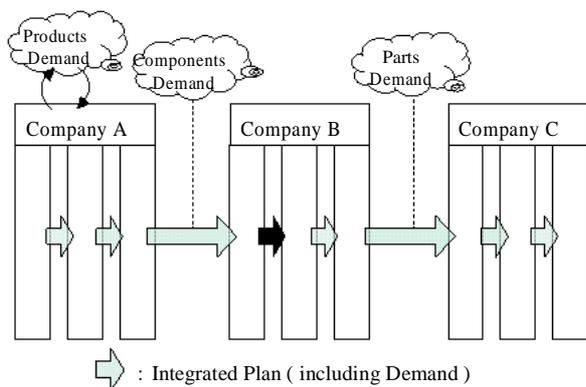


Fig. 3: Dependent demand model

However, this dependent demand model manages whole supply chain as one enterprise, and each company has no right to decide their own plan. Therefore, it is hard to apply it except a company group that has a capital relation each other.

We propose a new supply chain model as shown in

Fig.4. In this e-Community Model, the demand and supply information service center is set up. The service center feeds back demand /supply information which is calculated based on the latest plan information that is provided by each member company in this community. Each company can use that demand / supply information for their own decision-making of plan and provide the updated plan for the service center again.

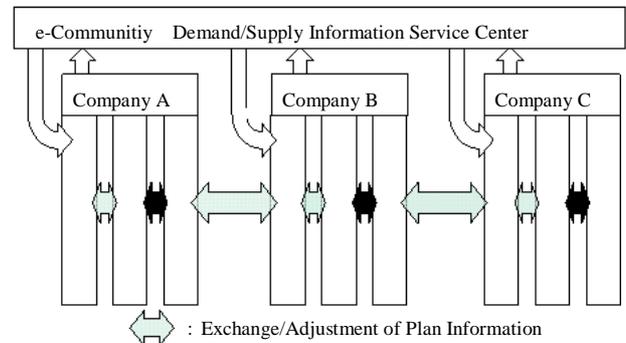


Fig. 4: e-Community Model

The features of this e-Community Model is as follows;

- 1) Each company can keep independency
- 2) Each company can share all plan information over whole supply chain through the service center

Especially in 2) above, each company can share tactics- to strategy-level information. The upper stream company can get demand information calculated based on the procurement plan of the lower stream companies, while the lower stream company can get the supply constraints calculated based on the supply plan of the upper stream company.

As the first step in our analysis for proposed e-Community Model, the present study modeled company activities in a way that considered decision-making not just over the execution-level, but also over the tactics- and strategy-level. Simulation was then used to investigate the impact of information sharing on company gross profits.

### 3. Modeling company activities

Based on the above supply chain-related activities - that is supply, transform and procurement - we developed a model to describe the activities of a typical company in the manufacturing industry. We then created a framework (Fig. 5) for the essential planning and decision-making activities of such a company, i.e. sales planning, production planning and procurement planning.

Activities were defined as planning activities (strategy-level, tactics-level and execution-level), instruction and results management activities, and logistics activities. An outline of each of these types of activities is given in Table 2.

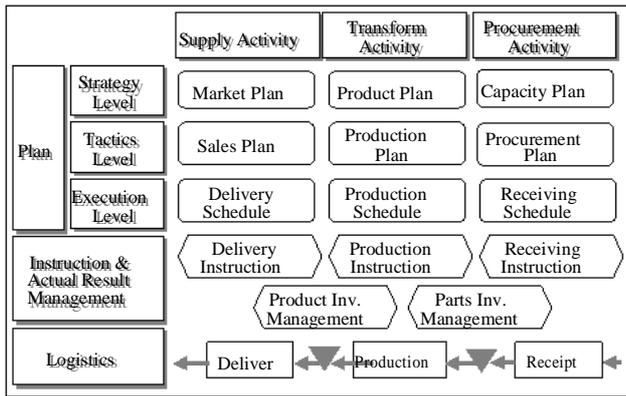


Fig. 5: Essential company activities for SCM

Table 2: Planning activities

Level	Activity	Description
Strategy Level	Market Plan	Make forecasts of future demand for applicable products based on long-term perspectives
	Product Plan	Develop a production prospect for applicable products over the relevant time frame on the basis of market plan
	Capacity Plan	On the basis of product plan, plan for the necessary production capacity (equipment and human resources)
Tactics Level	Sales Plan	Forecast sales volume from medium-term perspective Sales Plan
	Production Plan	Create a production plan in accordance with the sales plan, within the limits of capacity plan
	Procurement Plan	To achieve the production plan, calculate the quantity of parts and materials needed for relevant periods
Execution Level	Delivery Schedule	Determine product delivery dates, according to received orders
	Production Schedule	Determine manufacturing volume and dates according to the delivery schedule and production plans
	Receiving Schedule	In accordance with the production schedule, determine the delivery quantities and dates for parts orders placed

#### 4. Profit and loss evaluation model

In order to investigate the effect of information sharing on company gross profits, we created a profit and loss evaluation model (as shown in Fig. 6). The model breaks down costs into variable and fixed components and takes into account sales (according to received orders) and expenses for a given period. The unit prices for products, parts and labor used in calculating profit and loss are set on the basis of a product cost price structure (proportion of sales income for fixed costs such as direct material costs and labor costs).

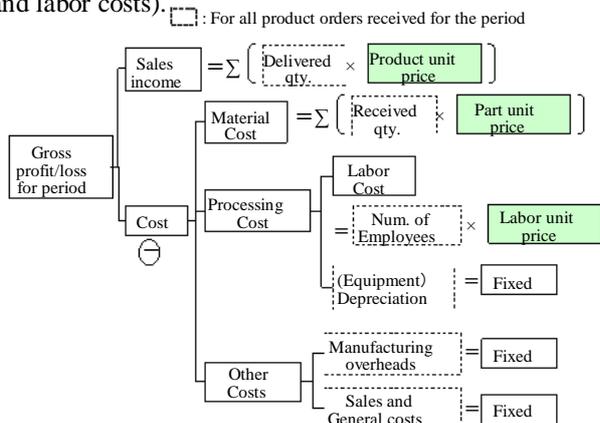


Fig. 6: Profit and loss evaluation model

#### 5. Information sharing models

We consider that information sharing between an assembly manufacturer and component manufacturer would work as shown in Fig. 7 below. In this study we investigated an information sharing system in which a component maker utilizes information from an assembly maker for forecasting demand

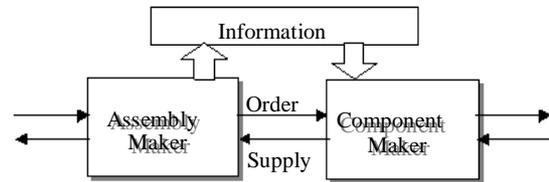


Fig. 7: Shared information flow between companies

##### 5.1 Information from the assembly maker

The assembly maker creates strategy-level and tactics-level plans of its operations. Thus, when the component maker needs to forecast demand for its products, it can utilize not only execution-level information from the assembly maker, such as inventory in hand and sales figures, but also tactics- and strategy-level planning information, as shown in Fig. 8. Examples of strategy-, tactics- and execution-level information used in this study are given in the table 3.

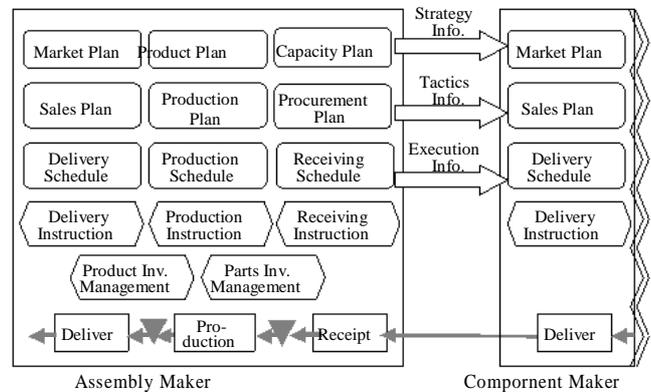
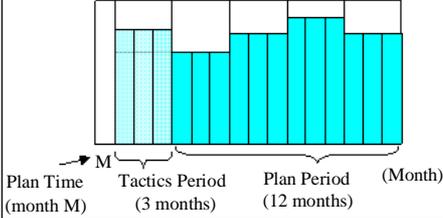
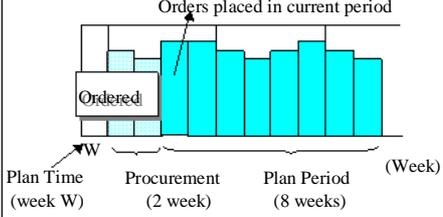


Fig. 8: Information from an assembly maker for use in demand forecasting by a component maker

The component maker can improve its capacity plan using the product plan of itself and monitoring the strategy-level product plan of the assembly maker, thus making more efficient use of production resources. In addition, by keeping track of the of assembly maker's procurement plan, the component maker can improve the efficiency of its own parts and materials ordering.

Table 3: Examples of information used in this study

<b>Strategy Information</b>	<p>Product Plan (long-term production plan of customers)</p>  <p>Plan Time (month M)    Tactics Period (3 months)    Plan Period (12 months)    (Month)</p>
<b>Tactics Information</b>	<p>Procurement Plan (future orders planned by customers)</p>  <p>Plan Time (week W)    Procurement (2 week)    Plan Period (8 weeks)    (Week)</p>
<b>Execution Information</b>	<p>Actual Inventory on hand Actual Sales figures</p>

### 5.2 Demand forecast method, using information from the assembly maker

In this study, we performed a demand forecast based on the assembly maker information listed in Table 3. Specifically, we did this using the market plan (strategy-level activity), sales plan (tactical-level activity) and delivery plan (execution-level activity). (See Fig. 4.)

The market plan quantity of component maker uses the product plan quantity of assembly maker as it is, while the sales plan quantity of component uses the procurement plan quantity of assembly maker as it is. Furthermore, the delivery schedule quantity of component maker is predicted based on the assembly maker’s sales figures and inventory on hand. Now, if the component maker does not make use of information from the assembly maker, it must determine plan quantities by making predictions based on orders received in the past.

## 6. Analysis of the impact of information sharing on gross profit

### 6.1 Outline of analysis

- No information: Information is not shared
- Execution-level information sharing: Only short-term information is shared
- Tactics-level information sharing: Tactics- and execution-level information is shared
- Strategy-level information sharing: Strategy-, Tactics- and execution-level information is shared

We analyzed how gross profits of the component maker and assembly maker vary with each of the above information-sharing methods.

### 6.2 Experimental conditions

This experiment was conducted based on the conditions below.

<Experimental conditions>

- 1 product = 1 component = 1 part
- Each maker operates by assembling and processing products after receiving orders.
- Evaluation period is 48 weeks (12 months)
- Capacity planning involves forecasting for human resources only, i.e. “equipment” capacity is assumed to be fixed.
- The costs of each maker as a percentage of revenue are assumed to be as follows: direct material costs 70%; labor costs 10%; other fixed costs 15%

The experiment was conducted for all four cases below, each representing a different demand pattern for the assembly maker. As shown in Table 4 below, each of the demand patterns is defined by monthly demand change rate, volatility and cycle.

Table 4: Demand patterns and parameters

Demand Pattern	Monthly Demand Change Rate	Volatility	Cycle
1. Up trend	+5%	10%	None
2. Down trend	-5%	10%	None
3. Cyclical trend	±5%	10%	9month
4. No trend	0%	10%	None

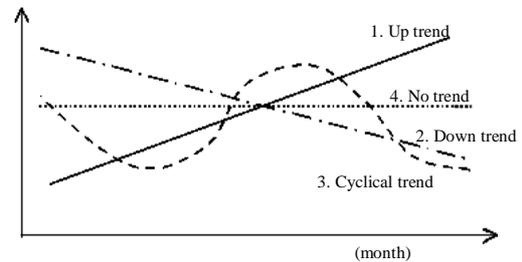


Fig. 9: Demand patterns

### 6.3 Impact on component maker gross profits

We analyzed how different information sharing methods (execution-, tactics- and strategy-level) affected the gross profits of the component maker.

The graph in Fig. 10 confirms that all three information sharing methods increase the gross profit of a component maker. In addition, for all demand patterns except “no trend” the impact on gross profit increases with the length of the planning period. The benefit of strategy-level information sharing is particularly large in the case of a “down trend” demand pattern. As shown by Fig. 11, this is due to the fact that strategy-level information sharing greatly improves resource utilization efficiency (=gross profit/ (labor cost + other fixed costs).

Clearly, the reason that strategy-level information sharing exerts very little effect on gross profits and resource utilization efficiency in the case of a “no trend”

pattern is that demand can be predicted quite accurately without information sharing, since there is essentially no change in demand.

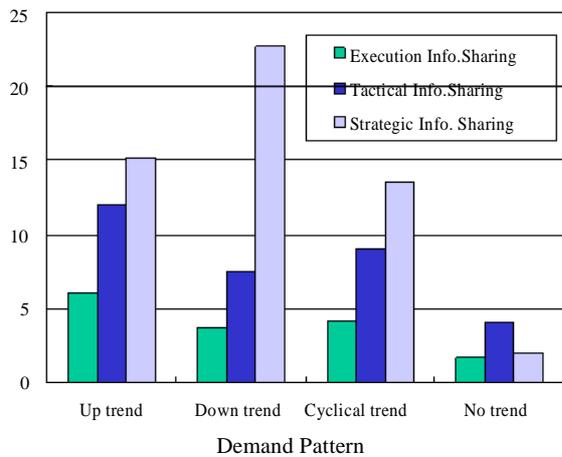


Fig. 10: Impact of information sharing on component maker gross profits

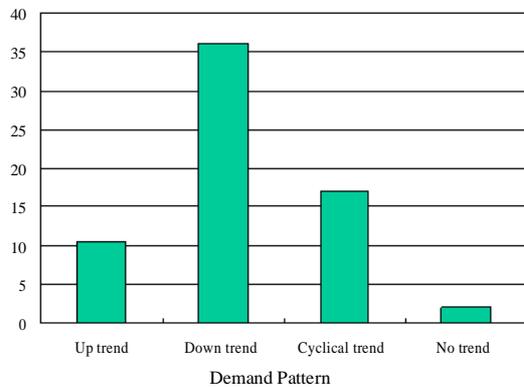


Fig. 11: Influence of strategy-level information sharing on resource utilization efficiency

#### 6.4 Impact on assembly maker gross profits

We analyzed how different information sharing methods (execution-, tactics- and strategy-level) affected gross profits of assembly makers.

Although the increase in gross profits for the assembly maker is less than that of the component maker, Fig. 12 shows that information sharing provides benefits even to the side supplying the information (the assembly maker in this case). The benefit is particularly large for the case of “up trend” demand.

As Fig. 13 shows, information sharing tends to reduce the order loss rate for the assembly maker. Thus, by providing its planning information to the component maker, the assembly maker can ensure a reliable supply of parts and materials and therefore reduce lost sales opportunities. This explains how benefits are gained from providing information.

Furthermore, despite the fact that tactics-level information sharing results in increased gross profits for the component maker (Fig. 10), average inventory has actually increased for this case (Fig. 13). This shows that even if average inventory is reduced, it does not

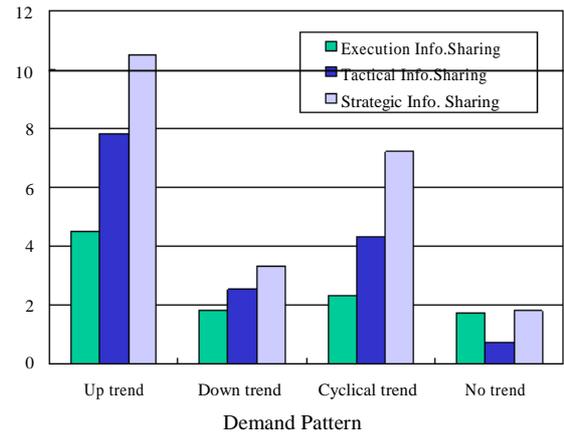


Fig. 12: Impact of information sharing on component maker gross profits

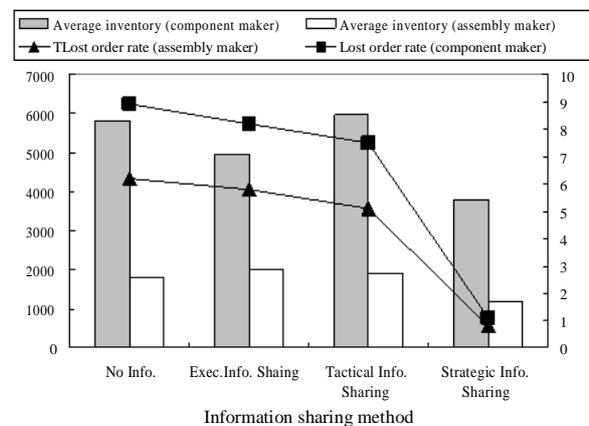


Fig. 13: Influence of information sharing on average inventory and lost order rate (“up trend” demand pattern)

necessarily follow that gross profits will increase. From this, we can conclude that the impact of information sharing needs to be evaluated by looking at gross profits not inventory.

#### 7. Conclusion

In this study on supply chains in the electronics industry, we confirmed that sharing information such as product plan and procurement plan between a component manufacturer and assembly manufacturer can lead to improved gross profits for all companies involved.

We demonstrated that the benefit of sharing information is greater in almost liner fashion as long as sharing information level is deeper from execution- and tactics- to strategy-level.

The increase in gross profit was seen to be particularly large in the case of declining demand. In addition, while earlier studies evaluated the impact of information sharing by looking at inventory levels, this study confirms that reducing inventory does not necessarily lead to improved gross profits, thereby highlighting the importance of gross profits as a measure for assessing the impact of information sharing.

## References

- [1] Atsushi Endo, Study on the Bull-whip Effect in Supply Chain Management Japan Industrial Management Association Autumn Research Conference Proceeding (1999)  
[2] Hau L. Lee, Information Distortion in a Supply Chain; The

Bullwhip Effect, Management Science, Vol. 43 (1997)

[3] Rintaro Muramatsu, Fundamentals of Production Management, Kunimoto Shobo (1979)

[4] Hopp, Spearman, Factory Physics: Foundation of Manufacturing Management, Irwin (1996)



# Upstream R&D Competition and Cooperation in a Two-Tier Supply Chain

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## Abstract

This paper derives a two-tier supply chain model with many firms in each tier. The upstream firms engage in cost-reducing R&D activities. Under the case of R&D competition, the paper discusses how the changes in R&D spillover, R&D efficiency and the numbers of the manufacturers and the suppliers affect the R&D expenditures, the quantities and the profits. Then, R&D cooperation is considered. And what effects arise with the changes in the R&D spillover and the degree of cooperation are studied.

**Key words:** supply chain, upstream firm, downstream firm, R&D competition, R&D cooperation

## 1. Introduction

The subject of R&D competition and cooperation has gained a lot of attention from researchers in a variety of settings. Such literature usually uses a two-stage game that firms choose their R&D expenditures before making decisions on production. [1] examines the impact of multinational presence on domestic firms' innovative efforts in a model focusing on the strategic dimension of R&D. [2] addresses the question about the optimal degree of spillovers and the number of rival firms necessary for obtaining the maximum amount of effective R&D. Both [1] and [2] only consider R&D competition between firms. Meanwhile, many papers consider R&D competition and cooperation simultaneously and make comparisons between them. [3] presents an interesting analysis of cooperative and non-cooperative R&D and compares the R&D investment and output under cooperative R&D with those under non-cooperative R&D. [4] extends the results in [3] to the case of more than two firms and more general demand and cost assumptions. [5]

extends the analytical framework in [3] to a two-industry, two-firm-per-industry model allowing for R&D spillovers to occur within industries as well as between industries. [6] compares duopoly outcomes between two alternative models of independent R&D and non-cooperative R&D, where there are complementarities between firm-specific R&D resources.

Besides the two-stage models, some papers introduce another stage game before the other games occur. [7] derives the non-cooperative, optimal policy towards international R&D cooperation. In the model, the governments simultaneously announce their R&D subsidy rates before the firms choose their R&D expenditures and quantities. [8] examines the impact of the firms' mode of foreign expansion on the incentive to innovate as well as the effects of R&D activities and technological spillovers on the firms' international strategy. [8] considers a two country imperfect competition model where the firms face three different type of decisions: how to expand abroad, how much to spend on R&D and how much to sell in each market.

Although there exist a lot of papers about R&D competition and cooperation, we can hardly find one under the case of supply chain. An exception may be [9] which derives a model that an integrated firm produces the input and engages in R&D to reduce the input production cost. The integrated firm sells the input to its rival at a regulated price and competes with it in the final product market. [9] examines input price regulation's effects on R&D and output. In our paper, we consider a two-tier supply chain with many firms in each tier. The upstream firms, the suppliers, conduct R&D activities that result in reduction in marginal cost. We use a parameter  $\beta$  to capture R&D spillovers between the

suppliers.<sup>1</sup> We first consider R&D competition and then R&D cooperation. Concerning R&D competition, we discuss how the changes in R&D spillover, R&D efficiency and the numbers of the manufacturers and the suppliers affect the R&D expenditures, the quantities and the profits. Under R&D cooperation, we study what effects arise with the changes in the R&D spillover and the degree of cooperation.

The two-tier-supply-chain structure with many firms in each tier in the paper is similar to that of [10]. Such kind of structure also appears in [11] and [12]. [10] examines the impact of fixed and variable costs on the structure and competitiveness. [11] examines vertical integration as an equilibrium phenomenon and consider the issue of private profitability versus collective profitability. [12] analyses the effects of different institutional arrangements of union-firm bargaining.

## 2. The Model

Consider a two-tier supply chain with  $n_1$  firms, the manufacturers, in the downstream tier, and  $n_2$  firms, the suppliers, in the upstream tier. The firms in the same tier engage in Cournot competition. The suppliers sell a homogeneous input at price  $p_2$  to the manufacturers which use it to produce a final product. Without loss of generality, we assume that one unit of final product requires one unit of input. The inverse demand function of the final product is  $p_1 = a - bQ_1$ , where  $p_1$  is the price and  $Q_1$  is the total output. Denote the output of manufacturer  $i$  as  $q_{1,i}$ , then  $Q_1 = \sum_{l=1}^{n_1} q_{1,l}$ . The profit of a representative manufacturer is

$$\Pi_{1,i} = (p_1 - v_1 - p_2)q_{1,i} \quad (1)$$

where  $v_1$  is the constant marginal cost of the final

<sup>1</sup> The spillovers are often important parameters in the R&D literature and almost all the aforementioned papers consider the spillovers. [9] ignores the spillovers since only one firm conducts R&D activity and it is no need to consider them. It should also be noted that the spillover in [7] has the different meaning from other papers and ours. [7] uses the spillover effect to capture the degree of R&D collaboration while such parameters in other papers indicates the involuntary technological information leakage.

product.

The suppliers conduct R&D activities that result in reduction in marginal cost. Let  $x_j$  be the level of R&D investment undertaken by supplier  $j$  and let  $v_{2,j}$  denote supplier  $j$ 's marginal cost. In order to model the possibility of imperfect appropriability (i.e., technological spillovers between the suppliers), we introduce a spillover parameter  $\beta \in [0,1]$ . This means that the magnitude of supplier  $j$ 's cost reduction is determined by its own technological knowledge and by a fraction  $\beta$  of the sum of the other suppliers' knowledge. More specifically

$$v_{2,j} = v_2^0 - \sqrt{gx_j} - \beta \sum_{\substack{m=1 \\ m \neq j}}^{n_2} \sqrt{gx_m} \quad (2)$$

where the parameters  $g$  and  $v_2^0$  describe the efficiency of the R&D process and the initial marginal production cost of the suppliers. The expression  $\sqrt{gx_j}$  is an R&D production function which reflects the existence of diminishing return to R&D expenditures and can be seen in many papers<sup>[3][8][13][14]</sup>. The profit of supplier  $j$  is

$$\Pi_{2,j} = (p_2 - v_{2,j})q_{2,j} \quad (3)$$

where  $q_{2,j}$  is supplier  $j$ 's output.

Now, we consider the decision problem of the manufacturers. Manufacturer  $i$  chooses its output to maximize its profit by taking the other manufacturers' output as given. The first-order condition can be derived from (1), which is

$$a - v_1 - p_2 - b(Q_1 + q_{1,i}) = 0$$

Since the manufacturers are identical, we can get

$$q_{1,i} = q_1 = \frac{a - v_1 - p_2}{b(n_1 + 1)}$$

and

$$Q_1 = n_1 q_1 = \frac{n_1(a - v_1 - p_2)}{b(n_1 + 1)} \quad (4)$$

In equilibrium, the overall output of the manufacturers and the suppliers must be equal. Substituting  $Q_2$  for  $Q_1$ , (4) can be rearranged to

$$p_2 = (a - v_1) - \frac{b(n_1 + 1)}{n_1} Q_2 \quad (5)$$

where  $Q_2 = \sum_{m=1}^{n_2} q_{2,m}$  is the overall output of the suppliers. Supplier  $j$  chooses  $q_{2,j}$  to maximize its profit.

From (3) and (5) we get the first-order condition as follows

$$a - v_1 - v_{2,j} - \frac{b(n_1 + 1)}{n_1} (Q_2 + q_{2,j}) = 0 \quad (6)$$

We can get  $n_2$  equations from (6) since  $j$  varies from 1 to  $n_2$ . Then, we can, respectively, derive the suppliers' total output and supplier  $j$ 's output as follows

$$Q_2 = \frac{n_1}{b(n_1 + 1)(n_2 + 1)} [n_2(a - v_1) - \sum_{m=1}^{n_2} v_{2,m}] \quad (7)$$

$$q_{2,j} = \frac{n_1}{b(n_1 + 1)(n_2 + 1)} [(a - v_1) - (n_2 + 1)v_{2,j} + \sum_{m=1}^{n_2} v_{2,m}] \quad (8)$$

Substituting (5), (7) and (8) into (3), we get

$$\Pi_{2,j} = \frac{n_1}{b(n_1 + 1)(n_2 + 1)^2} [(a - v_1) - (n_2 + 1)v_{2,j} + \sum_{m=1}^{n_2} v_{2,m}]^2 - x_j \quad (9)$$

### 3. R&D Competition

In this section, we first derive the equilibrium when the suppliers independently decide R&D expenditures to maximize their individual profits. Then we discuss what effects arise with changes in some parameters.

Substituting (2) into (9) results in

$$\Pi_{2,j} = \frac{n_1}{b(n_1 + 1)(n_2 + 1)^2} [(a - v_1 - v_2^0) + (n_2 + \beta - n_2\beta)\sqrt{gx_j} + (2\beta - 1)\sum_{\substack{m=1 \\ m \neq j}}^{n_2} \sqrt{gx_m}]^2 - x_j \quad (10)$$

Supplier  $j$  chooses its R&D investment,  $x_j$ , to maximize its profit. The first-order condition is

$$\frac{\partial \Pi_{2,j}}{\partial x_j} = \frac{n_1}{b(n_1 + 1)(n_2 + 1)^2} [(a - v_1 - v_2^0) + (n_2 + \beta - n_2\beta)\sqrt{gx_j} + (2\beta - 1)\sum_{\substack{m=1 \\ m \neq j}}^{n_2} \sqrt{gx_m}] \frac{(n_2 + \beta - n_2\beta)g}{\sqrt{gx_j}} - 1 = 0$$

from which we get

$$\sqrt{gx_j} = \sqrt{gx} = \frac{n_1 g (n_2 + \beta - n_2\beta) (a - v_1 - v_2^0)}{b(n_1 + 1)(n_2 + 1)^2 - n_1 g (1 - \beta + n_2\beta)(n_2 + \beta - n_2\beta)}$$

or

$$x_j = x = \frac{n_1^2 g (n_2 + \beta - n_2\beta)^2 (a - v_1 - v_2^0)^2}{[b(n_1 + 1)(n_2 + 1)^2 - n_1 g (1 - \beta + n_2\beta)(n_2 + \beta - n_2\beta)]^2} \quad (11)$$

We need the following condition

$$b(n_1 + 1)(n_2 + 1)^2 > n_1 g (1 - \beta + n_2\beta)(n_2 + \beta - n_2\beta) \quad (12)$$

to ensure that the discussions are practical.

Now, we get

$$\Pi_{2,j} = \Pi_2 = \frac{n_1 [b(n_1 + 1)(n_2 + 1)^2 - n_1 g (n_2 + \beta - n_2\beta)^2] (a - v_1 - v_2^0)^2}{[b(n_1 + 1)(n_2 + 1)^2 - n_1 g (1 - \beta + n_2\beta)(n_2 + \beta - n_2\beta)]^2} \quad (13)$$

$$Q_1 = Q_2 = Q = \frac{n_1 n_2 (n_2 + 1) (a - v_1 - v_2^0)}{[b(n_1 + 1)(n_2 + 1)^2 - n_1 g (1 - \beta + n_2\beta)(n_2 + \beta - n_2\beta)]}$$

$$q_{1,i} = q_1 = \frac{n_2(n_2+1)(a-v_1-v_2^0)}{[b(n_1+1)(n_2+1)^2 - n_1g(1-\beta+n_2\beta)]}$$

$$q_{2,j} = q_2 = \frac{n_1(n_2+1)(a-v_1-v_2^0)}{[b(n_1+1)(n_2+1)^2 - n_1g(1-\beta+n_2\beta)]}$$

$$\Pi_{1,i} = \Pi_1 - bq_1^2$$

**Proposition 1** Each supplier's R&D expenditure increases with R&D efficiency and the number of the manufacturers and decreases with the number of the suppliers.

**Proof** From (11) we can immediately get  $\frac{\partial x}{\partial g} > 0$  and  $\frac{\partial x}{\partial n_1} > 0$ . Thus, the R&D effort of the suppliers increases if R&D activities are more efficient or there are more manufacturers.

Partially differentiating (11) with respect to  $n_2$ , we get

$$\text{Sign}\left\{\frac{\partial x}{\partial n_2}\right\} = \text{Sign}\{n_1g\beta(n_2 + \beta - n_2\beta)^2 - b(n_1+1)(n_2+1)(n_2 - n_2\beta + 3\beta - 1)\} \quad (14)$$

After some simple manipulations, we can show that

$$\begin{aligned} & b(n_1+1)(n_2+1)(n_2 - n_2\beta + 3\beta - 1) \\ & \geq \frac{b(n_1+1)(n_2+1)^2(n_2 + \beta - n_2\beta)}{1 - \beta + n_2\beta} \end{aligned} \quad (15)$$

always holds since it is equivalent to  $(n_2 - 1)(2\beta - 1)^2 \geq 0$ , which is undoubtedly true.

Substituting the inequality in (12) into (15) yields

$$\begin{aligned} & b(n_1+1)(n_2+1)(n_2 - n_2\beta + 3\beta - 1) \\ & > n_1g\beta(n_2 + \beta - n_2\beta)^2 \end{aligned}$$

which leads to  $\frac{\partial x}{\partial n_2} < 0$  from (14). Thus, each supplier

invests less in R&D if more firms exist in the upstream tier.

**Proposition 2** (1) For large spillovers ( $\beta \geq 0.5$ ), the suppliers reduce their R&D expenditures when the spillover increases. (2) We can not unambiguously indicate how the R&D investments vary with the spillover if  $\beta < 0.5$ . However, the less the numbers of the manufacturers and the suppliers, the lower the R&D efficiency and the higher the spillover are, the more likely that the R&D investments decrease.

**Proof** Partially differentiating (11) with respect to  $\beta$ , we have

$$\text{Sign}\left\{\frac{\partial x}{\partial \beta}\right\} = \text{Sign}\{n_1g(n_2 + \beta - n_2\beta)^2 - b(n_1+1)(n_2+1)^2\} \quad (16)$$

For  $\beta \geq 0.5$ , we get

$$\begin{aligned} & b(n_1+1)(n_2+1)^2 > n_1g(1-\beta+n_2\beta)(n_2+\beta-n_2\beta) \\ & \geq n_1g(n_2+\beta-n_2\beta)^2 \end{aligned} \quad (17)$$

from (12). Thus, we obtain  $\frac{\partial x}{\partial \beta} < 0$  from (16) and (17) for  $\beta \geq 0.5$ .

For  $\beta < 0.5$ ,  $\frac{\partial x}{\partial \beta} < 0$  holds only if

$$b(n_1+1)(n_2+1)^2 > n_1g(n_2 + \beta - n_2\beta)^2 \quad (18)$$

which ensures that the condition in (12) satisfies. (18) can be rewritten as

$$\frac{b(n_1+1)}{n_1} > \frac{g(n_2 + \beta - n_2\beta)^2}{(n_2+1)^2} \quad (19)$$

It can be seen that the left-hand side of (19) decreases with  $n_1$  while the right-hand side decreases with  $\beta$  and increases with  $g$  and  $n_2$  if  $\beta < 0.5$ . Hence, if  $\beta < 0.5$ , the greater  $\beta$  and the smaller  $n_1$ ,  $n_2$  and  $g$  are, the more likely that  $x$  decreases with  $\beta$ .

**Proposition 3** If an increase in the spillover occurs,

the quantity of each tier and each firm and the profit of each manufacturer increases if  $\beta < 0.5$  and decreases if  $\beta > 0.5$ .

**Proof** It is easily to get

$$\begin{aligned} \text{Sign}\left\{\frac{\partial Q}{\partial \beta}\right\} &= \text{Sign}\left\{\frac{\partial q_1}{\partial \beta}\right\} = \text{Sign}\left\{\frac{\partial q_2}{\partial \beta}\right\} \\ &= \text{Sign}\left\{\frac{\partial \Pi_1}{\partial \beta}\right\} = \text{Sign}\{1-2\beta\} \end{aligned}$$

which leads to Proposition 3 immediately.

**Proposition 4** (a) Each supplier's profit decreases with the spillover if  $\beta \geq \frac{2n_2-1}{3(n_2-1)}$ . (b) It can not generally concluded how the profit varies with the spillover if  $\beta < \frac{2n_2-1}{3(n_2-1)}$ . However, the greater  $g$ ,  $n_1$ ,  $n_2$  and  $|0.5-\beta|$  are, the more likely that the profit decreases with  $\beta$ .

**Proof** Partially differentiating (13) with respect to  $\beta$  leads to

$$\begin{aligned} \text{Sign}\left\{\frac{\partial \Pi_2}{\partial \beta}\right\} &= \text{Sign}\{b(n_1+1)(n_2+1)^2[(2n_2-1)- \\ & 3(n_2-1)\beta] - n_1g(n_2+\beta-n_2\beta)^3\} \end{aligned} \quad (20)$$

The term in the square brackets of the right-hand side of (20) is negative if  $\beta \geq \frac{2n_2-1}{3(n_2-1)}$ . This proves the first part of Proposition 4.

If  $\beta < \frac{2n_2-1}{3(n_2-1)}$ , we can get from (20) that

$$\begin{aligned} \text{Sign}\left\{\frac{\partial \Pi_2}{\partial \beta}\right\} &= \text{Sign}\{\phi_1\} \\ \phi_1 &\equiv \frac{b(n_2+1)^2[(2n_2-1)-3(n_2-1)\beta]}{(n_2+\beta-n_2\beta)^3} - \frac{n_1}{n_1+1}g \end{aligned}$$

We have

$$\frac{\partial \phi_1}{\partial g} < 0, \quad \frac{\partial \phi_1}{\partial n_1} < 0, \quad \frac{\partial \phi_1}{\partial n_2} < 0$$

$$\text{Sign}\left\{\frac{\partial \phi_1}{\partial \beta}\right\} = \text{Sign}\{1-2\beta\}$$

Therefore, the greater  $g$ ,  $n_1$ ,  $n_2$  and  $|0.5-\beta|$  are, the more likely that the profit decreases with  $\beta$ .

**Proposition 5** The quantity of each tier and each supplier increases with  $n_1$ . Each incumbent supplier's quantity decreases if new suppliers enter the market, i.e.,  $n_2$  increases.

**Proof** It is easy to get

$$\frac{\partial Q}{\partial n_1} > 0, \quad \frac{\partial q_2}{\partial n_1} > 0$$

$$\begin{aligned} \text{Sign}\left\{\frac{\partial q_2}{\partial n_2}\right\} &= \text{Sign}\{-b(n_1+1)(n_2+1)^2 + \\ & n_1g[1+(n_2+3)(n_2-1)(1-\beta\beta)]\} \end{aligned}$$

Noting that

$$\begin{aligned} & n_1g[1+(n_2+3)(n_2-1)(1-\beta\beta)] \\ & < n_1g(1-\beta+n_2\beta)(n_2+\beta-n_2\beta) \end{aligned}$$

and the condition in (12), we get  $\frac{\partial q_2}{\partial n_2} < 0$ .

**Proposition 6** (a) The total quantity of each tier increases with  $n_2$  if  $\beta=0.5$ . (b) It can not generally concluded how the number of the suppliers affects the quantity of each tier if  $\beta \neq 0.5$ . However, the greater  $n_1$ ,  $n_2$  and  $|0.5-\beta|$  are, the more likely that the total quantity decreases with  $n_2$ .

**Proof** It is easy to get

$$\text{Sign}\left\{\frac{\partial Q}{\partial n_2}\right\} = \text{Sign}\{\xi_1\}$$

$$\begin{aligned} \xi_1 &\equiv b(n_1+1)(n_2+1)^2 - \\ & n_1g[n_2^2 - (3n_2+1)(n_2-1)(1-\beta\beta)] \end{aligned}$$

If  $\beta=0.5$ , we can get  $\xi_1 > 0$  from condition (12) and hence  $\frac{\partial Q}{\partial n_2} > 0$ .

If  $\beta \neq 0.5$ , noting that

$$n_1 g [n_2^2 - (3n_2 + 1)(n_2 - 1)(1 - \beta)] > n_1 g (1 - \beta + n_2 \beta)(n_2 + \beta - n_2 \beta)$$

we can not unambiguously sign  $\xi_1$  from condition (12). However, if

$$\phi_2 \equiv b \frac{n_1 g [n_2^2 - (3n_2 + 1)(n_2 - 1)(1 - \beta)]}{n_1 + 1 (n_2 + 1)^2} > 0$$

we can get  $\frac{\partial Q}{\partial n_2} > 0$ . Noting that  $\frac{\partial \phi_2}{\partial n_1} < 0$ ,  $\frac{\partial \phi_2}{\partial n_2} < 0$

and  $\text{Sign}\{\frac{\partial \phi_2}{\partial n_2}\} = \text{Sign}\{1 - 2\beta\}$ , we know that the

greater  $n_1$ ,  $n_2$  and  $|0.5 - \beta|$  are, the more likely that  $Q$  decreases with  $n_2$ .

**Proposition 7** It can not generally concluded how the number of the manufacturers affects each incumbent manufacturer's quantity. However, the greater  $n_2$  and  $|0.5 - \beta|$  and the smaller  $g$  are, the more likely that each incumbent manufacturer's quantity decreases with  $n_1$ .

**Proof** It is easy to get

$$\text{Sign}\{\frac{\partial q_1}{\partial n_1}\} = \text{Sign}\{\xi_2\}$$

$$\xi_2 \equiv g(1 - \beta + n_2 \beta) \eta \left( \frac{1}{2} + n_2 \beta - \frac{1}{2} b \right) n_1 (n_2 + 1)^2 \quad (21)$$

We can not unambiguously indicate the sign of  $\xi_2$  from (12) and (21). However, if

$$g(1 - \beta + n_2 \beta) \eta \left( \frac{1}{2} + n_2 \beta - \frac{1}{2} b \right) n_1 (n_2 + 1)^2 < 0$$

i.e.  $\phi_3 \equiv \frac{g(1 - \beta + n_2 \beta) \eta \left( \frac{1}{2} + n_2 \beta - \frac{1}{2} b \right) n_1 (n_2 + 1)^2}{(n_2 + 1)^2} < 0$ , we

have  $\frac{\partial q_1}{\partial n_1} < 0$ . Noting that  $\frac{\partial \phi_3}{\partial g} > 0$ ,  $\frac{\partial \phi_3}{\partial n_2} < 0$  and

$\text{Sign}\{\frac{\partial \phi_3}{\partial n_2}\} = \text{Sign}\{1 - 2\beta\}$ , we know that the greater

$n_2$  and  $|0.5 - \beta|$  and the smaller  $g$  are, the more likely that  $q_1$  decreases with  $n_1$ .

#### 4. R&D Cooperation

In this section, we consider the case that the suppliers cooperate in R&D and remain competition in production.

Each supplier  $j$  chooses its R&D expenditure  $x_j$  to

maximize  $\Pi_{2,j} + \lambda \sum_{\substack{m=1 \\ m \neq j}}^{n_2} \Pi_{2,m}$ , where  $\lambda \in [0, 1]$

captures all possible degrees of R&D cooperation. In the extreme case of full cooperation (when  $\lambda=1$ ), each supplier chooses its R&D expenditure level to maximize their joint profits.

The decisions of the manufactures and suppliers on quantities keep the same as R&D competition in Section 2. However, supplier  $j$  chooses  $x_j$  to maximize

$\Pi_{2,j} + \lambda \sum_{\substack{m=1 \\ m \neq j}}^{n_2} \Pi_{2,m}$ . From (10), we get

$$\frac{\partial \Pi_{2,k}}{\partial x_j} = \frac{n_1}{b(n_1 + 1)(n_2 + 1)^2} [(a - v_1 - v_2^0) + (n_2 + \beta - n_2 \beta) \sqrt{g x_k} + (2\beta - 1) \sum_{\substack{m=1 \\ m \neq k}}^{n_2} \sqrt{g x_m}] \frac{(2\beta - 1)g}{\sqrt{g x_j}} \quad (22)$$

$$\frac{\partial \sum_{\substack{m=1 \\ m \neq j}}^{n_2} \Pi_{2,m}}{\partial x_j} = \frac{n_1}{b(n_1 + 1)(n_2 + 1)^2} [(n_2 - 1)(a - v_1 - v_2^0) + (n_2 + \beta - n_2 \beta) \sum_{\substack{m=1 \\ m \neq j}}^{n_2} \sqrt{g x_m} + (2\beta - 1)(\sqrt{g x_j} + (n_2 - 2) \sum_{\substack{m=1 \\ m \neq j}}^{n_2} \sqrt{g x_m})] \frac{(2\beta - 1)g}{\sqrt{g x_j}} \quad (23)$$

Supplier  $j$  will choose its R&D investment level according to the following first-order condition

$$\frac{\partial (\Pi_{2,j} + \lambda \sum_{\substack{m=1 \\ m \neq j}}^{n_2} \Pi_{2,m})}{\partial x_j} = 0$$

We can get the first-order condition as the function of each supplier's R&D level from (22) and (23). Since the suppliers are identical, the subscript of  $x$  can be deleted and the first-order condition is reduced to

$$\frac{n_1 g [(n_2 + \beta - n_2 \beta) + \lambda (n_2 - 1)(2\beta - 1)] \times}{b(n_1 + 1)(n_2 + 1)^2 \sqrt{g x^*}} \times [(a - v_1 - v_2^0) + (1 - \beta + n_2 \beta) \sqrt{g x^*}] - F = 0$$

Then we get

$$\sqrt{g x^*} = \frac{n_1 g [(n_2 + \beta - n_2 \beta) + \lambda (n_2 - 1)(2\beta - 1)] (a - v_1 - v_2^0)}{b(n_1 + 1)(n_2 + 1)^2 - n_1 g (1 - \beta + n_2 \beta) [(n_2 + \beta - n_2 \beta) + \lambda (n_2 - 1)(2\beta - 1)]} \quad (24)$$

We need the following condition

$$b(n_1 + 1)(n_2 + 1)^2 > n_1 g (1 - \beta + n_2 \beta) [(n_2 + \beta - n_2 \beta) + \lambda (n_2 - 1)(2\beta - 1)]$$

to ensure that the discussions are practical.

Substituting (24) into (7) yields

$$Q_1^* = Q_2^* = Q^* = \frac{n_1 n_2 (n_2 + 1) (a - v_1 - v_2^0)}{b(n_1 + 1)(n_2 + 1)^2 - n_1 g (1 - \beta + n_2 \beta) [(n_2 + \beta - n_2 \beta) + \lambda (n_2 - 1)(2\beta - 1)]} \quad (25)$$

We can also get

$$q_{1,i}^* = q_1^* = Q^* / n_1 \quad (26)$$

$$q_{2,j}^* = q_2^* = Q^* / n_2 \quad (27)$$

**Proposition 8** The R&D expenditures increases with  $\lambda$ , the degree of R&D cooperation.

**Proof** The proof is immediately followed from the

fact that  $\frac{\partial \sqrt{g x^*}}{\partial \lambda} > 0$ .

Noting that  $\lambda=0$  is actually the case that the suppliers do not cooperate in R&D, we know from Proposition 8 that the R&D investment level under cooperation is higher than that under competition. Furthermore, the larger the degree of cooperation is, the larger the gap of R&D level between cooperation and competition is. The gap reaches the largest value if the suppliers engage in full cooperation.

**Proposition 9** (a) The R&D investments increase with the spillover if the degree of cooperation is appropriately large, i.e.,  $\lambda \geq 0.5$ . (b) We can not generally indicate how the change in the spillover affects the R&D investment if  $0 < \lambda < 0.5$ . However, the greater  $\lambda$  and  $g$  and the smaller  $n_1$  and  $\beta$  are, the more likely that the R&D investments increase with  $\beta$ . If  $\beta < 0.5$ , the greater  $n_2$  is, the more likely that the R&D investment increases with  $\beta$ . If  $\beta > 0.5$ , the

smaller  $n_2$  is, the more likely that the R&D investment increases with  $\beta$ .

**Proof** Differentiating (24) with respect to  $\beta$  yields

$$\text{Sign}\left\{\frac{\partial \sqrt{g x^*}}{\partial \beta}\right\} = \text{Sign}\{\xi_3\} \quad (28)$$

$$\xi_3 \equiv b(2\lambda - 1)(n_1 + 1)(n_2 + 1)^2 + n_1 g (1 - \beta + n_2 \beta) [(n_2 + \beta - n_2 \beta) + \lambda (n_2 - 1)(2\beta - 1)]^2 \quad (29)$$

(a) If  $\lambda \geq 0.5$ , it can be easily shown that  $\xi_3 > 0$  and

hence  $\frac{\partial \sqrt{g x^*}}{\partial \beta} > 0$ .

(b) If  $0 < \lambda < 0.5$ , the first and second term on the right-hand side of (29) are, respectively, negative and positive. Thus, we can not unambiguously indicate the sign of  $\xi_3$ . We can rewrite (28) as

$$\text{Sign}\left\{\frac{\partial \sqrt{g x^*}}{\partial \beta}\right\} = \text{Sign}\{\phi_4\}$$

$$\phi_4 \equiv g + \frac{b(n_1 + 1)}{n_1} \times \frac{(2\lambda - 1)(n_2 + 1)^2}{(1 - \beta + n_2 \beta) [(n_2 + \beta - n_2 \beta) + \lambda (n_2 - 1)(2\beta - 1)]^2}$$

We obtain

$$\frac{\partial \phi_4}{\partial g} > 0, \quad \frac{\partial \phi_4}{\partial n_1} < 0$$

$$\text{Sign}\left\{\frac{\partial \phi_4}{\partial \beta}\right\} = \text{Sign}\{-(n_2 - 1)(2\lambda - 1)^2\}$$

$$\text{Sign}\left\{\frac{\partial \phi_4}{\partial \lambda}\right\} = \text{Sign}\{(n_2 + \beta - n_2\beta) + (n_2 - 1)(2\beta - 1)(1 - \lambda)\}$$

$$\text{Sign}\left\{\frac{\partial \phi_4}{\partial n_2}\right\} = \text{Sign}\{(1 - 2\beta)(2\lambda - 1)^2\}$$

Since  $0 < \lambda < 0.5$ , we can readily get  $\frac{\partial \phi_4}{\partial \beta} < 0$  and

$\frac{\partial \phi_4}{\partial \lambda} > 0$ . In addition,  $\frac{\partial \phi_4}{\partial n_2} > 0$  if  $\beta < 0.5$  and

$\frac{\partial \phi_4}{\partial n_2} < 0$  if  $\beta > 0.5$ .

**Proposition 10** When the degree of R&D cooperation changes, the quantity of each tier and each firm increases if  $\beta > 0.5$ , decreases if  $\beta < 0.5$  and remains unchanged if  $\beta = 0.5$ .

**Proof** From (25), (26) and (27), we have

$$\text{Sign}\left\{\frac{\partial Q^*}{\partial \lambda}\right\} = \text{Sign}\left\{\frac{\partial q_i^*}{\partial \lambda}\right\} = \text{Sign}\{2\beta - 1\}$$

which leads to the proposition immediately.

**Proposition 11** (a) If  $\lambda \geq \frac{n_2 - 1}{3n_2 - 1}$ , the quantity of each tier and each firm increases with  $\beta$ . (b) If  $\lambda < \frac{n_2 - 1}{3n_2 - 1}$ , the quantity may increase or decrease with  $\beta$ . The smaller  $\beta$  is, the more likely that the quantity increases with  $\beta$ .

**Proof** From (25), (26) and (27), we get

$$\text{Sign}\left\{\frac{\partial Q^*}{\partial \beta}\right\} = \text{Sign}\left\{\frac{\partial q_i^*}{\partial \beta}\right\} = \text{Sign}\{\xi_4\}$$

$$\xi_4 \equiv (n_2 - 1)n\lambda(1 - \beta) - 2(n_2 - 1)(2\lambda - 1)\beta$$

(a) If  $\lambda \geq 0.5$ , we have

$$\xi_4 \geq n(n_2 - 1)n(n_2 - 3) > 0$$

If  $\lambda < 0.5$ , we can obtain

$$\begin{aligned} \xi_4 &\geq (n_2 - 1) - \lambda(n_2 - 3) + 2(n_2 - 1)(2\lambda - 1) \\ &= (3n_2 - 1)\lambda - (n_2 - 1) \end{aligned} \quad (30)$$

If  $\frac{n_2 - 1}{3n_2 - 1} \leq \lambda < 0.5$ , from (30) we get  $\xi_4 \geq 0$  and the equation holds only when  $\beta = 1$ .

(b) If  $\lambda < \frac{n_2 - 1}{3n_2 - 1}$ , we obtain

$$\frac{\partial \xi_4}{\partial \beta} = 2(n_2 - 1)(2\lambda - 1) < 0$$

This completes the proof.

## 5. Conclusion

This paper has derived a model with upstream R&D in a two-tier supply chain. We considered R&D cooperation as well as R&D competition. Under R&D competition, we studied how the changes in R&D spillover, R&D efficiency and the numbers of the suppliers and the manufacturers affect R&D investments, quantities and profits. Under R&D cooperation, we showed that how R&D investments and quantities change with R&D spillover and the degree of R&D cooperation. The main results in the paper are given in eleven propositions.

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## References

- [1] Veugelers, R., Vanden Houte, P., 1990. Domestic R&D in the presence of multinational enterprises. *International Journal of Industrial Organization* 8(1), 1-15
- [2] de Bondt, R., Slaets, P., Cassiman, B., 1992. The degree of spillovers and the number of rivals for maximum effective R&D. *International Journal of Industrial Organization* 10(1), 35-54
- [3] d'Aspremont, C., Jacquemin, A., 1988. Cooperative and noncooperative R&D in duopoly with spillovers. *American Economic Review* 78(5), 1133-1137

- [4] Suzumura, K., 1992. Cooperative and noncooperative R&D in an oligopoly with spillovers. *American Economic Review* 82(5), 1307-1320
- [5] Steurs, G., 1995. Interindustry R&D spillovers: What difference do they make? *International Journal of Industrial Organization* 13(2), 249-276
- [6] Anbarci, N., Lemke, R., Roy, S., 2002. Inter-firm complementarities in R&D: a re-examination of the relative performance of joint ventures. *International Journal of Industrial Organization* 20, 191-213
- [7] Qiu, L. D., Tao, Z., 1993. Policy on international R&D cooperation: Subsidy or tax? *European Economic Review* 42(9), 1727-1750
- [8] Petit, M. L., Sanna-Randaccio, F., 2000. Endogenous R&D and foreign direct investment in international oligopolies. *International Journal of Industrial Organization* 18(2), 339-367
- [9] Goel, R. K., 1999. R&D and output in a regulated vertically integrated oligopoly. *Bulletin of Economic Research* 51(4), 339-347
- [10] Corbett, C. J., Karmarkar U. S., 2001. Competition and structure in serial supply chains with deterministic demand. *Management Science* 47(7), 966-978
- [11] Abiru, M., Nahata, B., Raychaudhuri, S., Waterson, M., 1998. Equilibrium structures in vertical oligopoly. *Journal of Economic Behavior & Organization* 37, 463-480
- [12] Grandner, T., 2001. Unions in oligopolistic, vertically connected industries. *European Economic Review* 45, 1723-1740
- [13] Poyago-Theotoky, J., 1995. Equilibrium and optimal size of a research joint venture in an oligopoly with spillovers. *Journal of Industrial Economics* 43(2), 209-226
- [14] Žigjć, K., Intellectual property rights violations and spillovers in North-South trade. *European Economic Review* 42(9), 1779-1799

# A Decision Support System for Construction Project Risk Assessment

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## Abstract

This paper presents an integrated system in which a computer-based decision support system (DSS) for construction project risks assessment at stage of contracting and construction. The Analytic Hierarchy Process (AHP) method is used to determine the weightings of risk factors from subjective judgment of experts and practitioners, and Fuzzy Multiple Criteria Decision Making (FMCDM) is used to assess the synthetic judgment of risk degree for the main activities of a construction project in different phase. A simple case study illustrates the effectiveness of the proposed approach and developed system.

## 1. Introduction

Construction is one of the most dynamic, risky, challenging, and rewarding industrial sectors [16]. Accordingly, construction activities are uncertain and variable, and associated risks are often permanent and complex in construction projects. Especially, large-scale construction projects (such as high-rise commercial building projects and mass transit system projects, and mountain tunnel construction projects) are becoming increasingly complex and variable in nature, and many risk and uncertainty factors are inherent. However, the construction industry often has a poor reputation for dealing with risk and uncertainty adequately, resulting in poor performance with failure to meet schedule deadlines and budgets, and attendant loss to both contractors and owners [15] [27]. In this case, effective risk and uncertainty management is a form of incentive to the contractors, as their profit margin will often be secured or even improved. This is particularly significant as projects including large capital outlays, unbalanced cash flows, significant new technology, unusual legal or contractual arrangements and sensitive environmental or safety issues

[5]. However, construction risk and uncertainty can seldom, if ever, be eliminated. A comprehensive risk and uncertainty analysis is not necessary to prevent cost and schedule overruns but, at least, it will give those parties a more rational basis on which to make decision.

A number of analysis model reported in the literature that provide management knowledge on the risk and uncertainty inherent in a project and lead to better decision outcomes. These risk handle methods can be considered to fall into three categories: (1) probability analysis [11] [13] [28] [31]; (2) interval analysis [2] [7] [18]; and (3) fuzzy set analysis [15] [20] [25] [26]. Probabilistic analysis techniques include sensitivity analysis, basic probability analysis, decision-tree analysis, Monte Carlo simulation. However, some of literature studies and surveys reported indicate that probability risk analysis is not widely accepted [1]. Interval analysis uses ranges for input variables to estimate plausible ranges of the results. However, it is difficult to define the intervals of input variables when the boundaries of the intervals are uncertain. A fuzzy set approach, pioneered by Zadeh [32], is a means for modeling uncertainty (or imprecision) arising from mental phenomena, which are neither random nor stochastic [9]. It is useful for uncertainty analysis where a probabilistic data is not available or when interval values of input variables are uncertain. Thus, this study attempts to apply the Analytic Hierarchy Process (AHP) to determine the impact weights of risk factors from subjective judgment of experts and practitioners. Further, the Fuzzy Multiple Criteria Decision Making (FMCDM) was used to assess the synthetic judgment of degree of risk for the main activities of a construction project in different phase. On the other hand, due to advances in computer technologies and current information exchange capabilities, there exists a need to develop a decision support system (DSS) that will assist the contractors in making critical risk management decisions at the stages of contracting and construction. Thus, the aim of this paper is to present a

systemic approach of the implementation of DSS in risk assessment of construction project. Initially, the establishment of a hierarchical structure for tackling the problem of construction risk and uncertainty identification is discussed, and a brief introduction to FCMCDM methods. Then, introduce the DSS framework that we developed. Finally, concluding remarks are presented.

## 2. Construction Project Risk Assessment Model

The purpose of this section is to establish a hierarchical structure for tackling the problem of risk assessment of a construction project. The contents include three subsections: constructing the hierarchical structure of risk factors for a general construction project, determining the assessment factors weights, and getting the synthetic judgment value.

### 2.1 Constructing the Hierarchical Structure of Risk Assessment Factors

Many researchers have tried to tackle the problems of risk and uncertainty identification in construction projects. Chapman [7] define the sources of risk as a risk hierarchy composed of four “layers”: the environment, the industry, the client and the project. Wideman [30] has compiled a risk identification breakdown structure as a framework of the major sources of risk which is subdivided into five classifications of risk: external unpredictable, external predictable but uncertain, internal (non-technical), technical and legal. Smith and Bohn [24] classified project risk into eight broad categories: natural risks, design risks, logistic risks, financial risks, legal and regulatory risks, political risks, construction risks and environment risks. Raftery [21] considers that there are three separate areas of risk: risk internal to the project, risk external to the project, and the client/the project/project team and project documentation. Conroy and Soltan [10] refer to four categories of risk, namely human failings, organizational failings, design group failings and design process failings. Charoengnam and Yeh [8] categorized construction risks into six groups: construction related, performance related, physical, financial and economic, contractual and legal, political and societal. Tah and Carr [25] [26] built a hierarchical risk-breakdown structure, which separated project risk into two main groups: external risk (including economic, physical, political and technological change) and internal risk (including five sub-items in local risk and eleven items in global risk). Thompson and Perry [27] listed sixteen sources of risk, five of which related to construction and three to finance issues.

The assessing hierarchical structure for project risk and uncertainty should provide evaluators the convenience for practical usage and easy understanding. Therefore, the assessment structure should avoid too complex on risk factors and the hierarchy need to express the basic risk and uncertainty condition for a project. The key

dimensions and the factors for construction project risk assessing were derived through previous literature review, comprehensive investigation and consultation with several experts, including one professor in architectural engineering, one professor in civil engineering, one experienced contractor. There are five risk and uncertainty dimensions, including economic and financial, contractual and legal, physical and construction related, managerial and performance related, political and societal. From these, twenty assessing factors for the hierarchical structure were used in this study. The hierarchical structure adopted in this study is shown in Fig. 1.

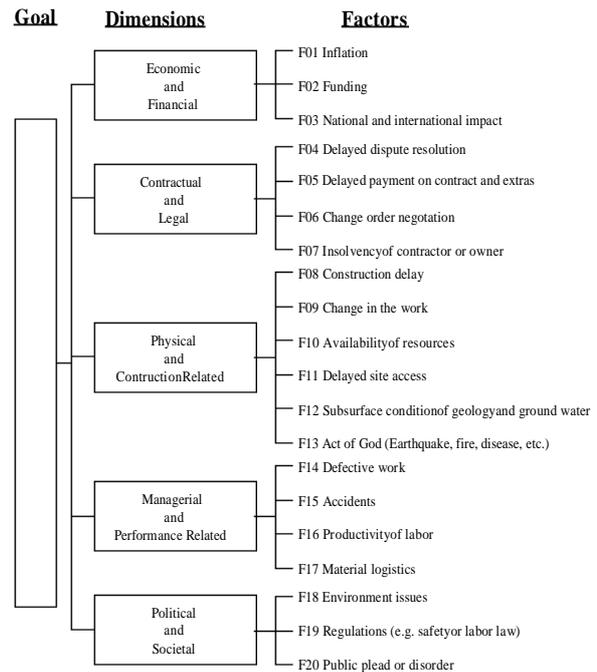


Fig. 1 The Hierarchical Structure for Risk Assessment of Construction Project

### 2.2 Determining the Risk Assessment Factors Weights

Several criteria are used in judging whether the level of risk is high or low, such as the degree of seriousness and the subsequent impact if this risk factor does occur. In this study the impact which is the degree of seriousness and the scale of the impact on project activities if the undesirable thing occurs [35]. However, the factors of project risk and uncertainty assessing have diverse significance and meanings, we cannot assume that each assessing factor is of equal importance. There are many methods that can be employed to determine weights [14] such as the eigenvector method, weighted least square method, entropy method, AHP, and LINMAP (linear programming techniques for Multidimensional of Analysis Preference). The selection of method depends on the nature of the problem. To assess project risk impact is both a complex and wide-ranging problem, so this problem requires the most inclusive and flexible method.

Since the AHP method can systematize complicated problems, is easy to operate, and integrates the experts' or evaluators' opinions. Therefore, in this study, the AHP method to assess the impact of risk factors is suggested. AHP weightings are mainly determined by evaluators who conduct pairwise comparisons of all factors with respect to certain criteria, deals with the relative priority or importance of each factor [22] [23]. The process of determining the importance order among criteria (risk assessment factors) is based on matrix computations and involves pairwise comparison of the various criteria in pairwise comparison matrix such as follow:

$$A = \begin{bmatrix} 1 & a_{12} & \dots & a_{1n} \\ 1/a_{12} & 1 & \dots & a_{2n} \\ \dots & \dots & \dots & \dots \\ 1/a_{1n} & 1/a_{2n} & \dots & 1 \end{bmatrix}$$

A matrix  $A = (a_{ij})$  where  $i, j = 1, 2, \dots, n$ , is established for evaluation of criteria and each criterion,  $a_i$  is compared with another criterion,  $a_j$ . The importance of one criterion over the other is established by utilizing a predetermined scale (refer to Table 1), thus defining  $a_{ij} = w_i/w_j$ , where  $w_i/w_j$  signifies the importance (or weight) of criterion  $a_i$  over criterion  $a_j$  and  $i, j = 1, 2, \dots, n$ . All entries in this matrix are positive and by definition satisfy the condition for a reciprocal matrix,  $a_{ji} = 1/a_{ij}$

Table 1 Comparison scale

Degree of importance	Definition
1	Equal importance of elements
3	Weak importance of one element over another
5	Strong importance of one element over another
7	Demonstrated or very strong importance of one element over another
9	Absolute importance of one element over another
2, 4, 6, 8	Intermediate values between two adjacent degrees of importance

The pairwise comparison of criteria based on the predetermined scale and its organization in a matrix form facilitates further analysis of the information. The relative comparisons of various criteria represent the elements,  $a_{ij}$ , of the upper triangle of the comparison matrix. The lower triangle of the matrix is established by taking the corresponding reciprocals from the upper triangle. The relative importance of criteria or the priority vector is established by computing the eigenvector corresponding to the maximum eigenvalue of the comparison matrix. It

is important that consistency should be maintained during the pairwise comparisons, that is,  $a_{jk} = a_{ik}/a_{ij}$  where  $i, j, k = 1, 2, \dots, n$ . Analytical Hierarchy Process allows for reasonable deviations in consistent comparison and does not require the consistency to be in exact mathematical proportions. The consistency of  $(n \times n)$  matrix can be established by computing the consistency ratio (C.R.) for the matrix, as defined in Eqs. (1) and (2).

$$\text{Consistency Ratio (C.R.)} = \frac{\text{C.I.}}{\text{R.I.}} \tag{1}$$

$$\text{Consistency Index (C.I.)} = \frac{\lambda_{\max} - n}{n - 1} \tag{2}$$

where, Random Index (R.I.) is defined as the average C.I. for a large number of reciprocal matrices of the same order with random entries, and  $\lambda_{\max}$  is the maximum eigenvalue of the matrix under consideration. Empirical studies conducted by Saaty have indicated that a deviation in consistency ratio of less than 10% is acceptable without adversely affecting the results. If the consistency ratio for a matrix is greater than 0.1 then, either the values in the matrix should be rejected or else, steps should be taken to modify the pairwise comparisons till an acceptable consistency ratio is obtained. The procedure for AHP can be summarized in seven steps as follows:

- Step 1** Set up the hierarchy system by decomposing the problem into hierarchy of interrelated elements.
- Step 2** Construct pairwise comparison matrices among all the elements in the dimensions of the hierarchy system. Assign the ratio values to the pairwise comparisons by asking which is the more important of each two factors.
- Step 3** Solves the eigenvector of the comparison matrix and establishes the relative weight for the dimensions level.
- Step 4** Check for consistency of the matrix.
- Step 5** Repeat Steps 3 and 4 at all descending factor levels of the hierarchy.
- Step 6** Multiply the weights of the factors at the upper levels down to the factors at the lower levels along with their vertical relationship.
- Step 7** Determine the aggregate relative weights of the decision elements to arrive at a set of ratings for the decision alternatives/strategies.

The final importance weight of every factor provides a basis for considering the priority of the impact to the various risks in a certain kind of construction project.

### 2.3 Getting the Synthetic Judgment Value

In daily life, we often hear people to express their opinion with “not very clear”, “probably so”, or “very likely”, indicating that they have some uncertainty or imprecise judgment. With different daily decision-making problems of diverse intensity, the results can be

misleading if the fuzziness (vagueness/uncertainty) of human decision-making is not taken into account. However, since Zadeh put forward fuzzy theory [32], and Bellman and Zadeh [3] described the decision-making method in fuzzy environments, an increasing number of studies have dealt with uncertain fuzzy problems by applying fuzzy set theory. Owing to a construction project often belong to uniqueness, inconsistency and data incompleteness. It is not easy to search available numerical information related to risk factors from another projects since the lack of historical records reservation in many cases. Therefore, the main way to estimate possibility of a risk factor occurrence for an activity of project is subjective judgment by project managers or experts. Since the subjective judgment is a fuzzy behavior in decision-making. Thus, this study includes fuzzy decision-making theory, considering the possible fuzzy subjective judgment of the evaluators during their evaluation of the construction project activities. The applications of fuzzy theory in this study are elaborated as follows:

**a. Fuzzy Numbers**

Fuzzy numbers are a fuzzy subset of real numbers, representing the expansion of the idea of the confidence interval. According to the definition of Dubois and Prades [12], fuzzy numbers should possess the following basic features.

Fuzzy number  $\tilde{A}$  is of a fuzzy set, and its membership function is  $\mu_{\tilde{A}}(x): R \rightarrow [0,1]$ , and it is enshrined with the following characteristics:

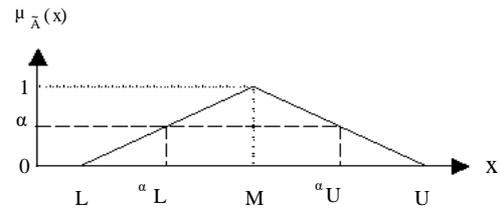
- (i)  $\mu_{\tilde{A}}(x)$  is a continuous mapping from R to the closed interval [0,1];
- (ii)  $\mu_{\tilde{A}}(x)$  is a convex fuzzy subset;
- (iii)  $\mu_{\tilde{A}}(x)$  is the normalization of a fuzzy subset, which means that there exists a number  $x_0$  that makes  $\max \mu_{\tilde{A}}(x_0) = 1$ .

Those numbers that can satisfy these requirements will then be called fuzzy numbers, and the following is an explanation for the characteristics and the operation of a triangular fuzzy number  $\mu_{\tilde{A}}(x)=(L, M, U)$  as shown in equation (3).

$$\mu_{\tilde{A}}(x) = \begin{cases} \frac{(x-L)}{(M-L)} & L \leq x \leq M \\ \frac{(U-x)}{(U-M)} & M \leq x \leq U \\ 0 & \text{otherwise} \end{cases} \quad (3)$$

Moreover, the set of elements that belong to the fuzzy set  $\tilde{A}$  at least to the degree  $\alpha$  is called  $\alpha$ -level set :

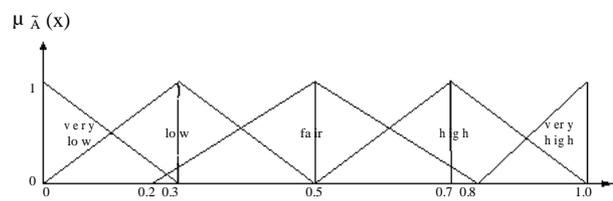
$$\forall \alpha \in [0,1], \tilde{A} \text{ of } \alpha\text{-cut shows } \alpha\tilde{A} \text{ and } \alpha\tilde{A} = [(M - L)\alpha + L, (U - M)\alpha + M] = [L, U] \quad (4)$$



**Figure 2. The membership function of the triangular fuzzy number**

**b. Linguistic Variable**

According to Zadeh [33], it is very difficult for conventional quantification to express reasonably those situations that are overtly complex or hard to define; thus, the notion of a linguistic variable is necessary in such situation. A linguistic variable is a variable whose values are words or sentences in a natural or artificial language. For example, the expressions of occurrence possibility of risk factors as “inflation,” “change order negotiation,” “delayed site access,” “accidents,” “public plead or disorder,” and so on all represent a linguistic variable in the context of this study. Linguistic variables may take on effect-values such as “very high”, “high”, “fair”, “low”, “very low”. Triangular fuzzy numbers, as shown in Fig. 3, can indicate the membership functions of the expression values. The use of linguistic variables is currently widespread, and the linguistic values found in this study are primarily used to assess the linguistic ratings given by the evaluators. Furthermore, linguistic variables are used as a way to measure the scope of occurrence possibility for each risk factor.



**Fig. 3 Membership Function of the Five Levels of Linguistic Variables**

**c. Fuzzy Multiple Criteria Decision-Making (FMCDM)**

Bellman and Zadeh[3] were the first to probe into the decision-making problem under a fuzzy environment, and they heralded the initiation of FMCDM. This study uses this method to evaluate and rank the degrees of risk for construction project activities. The following will be the method and procedures of the FMCDM theory.

- (1) Measurement criteria: Using the measurement of linguistic variables to demonstrate the risk factors possibility by expressions such as “very high”, “high”, “fair”, “low”, “very low”, the evaluators are asked for conduct their subjective judgments, and each linguistic variable can be indicated by a triangular fuzzy number (TFN) within the scale range of 0-1.0. In addition, the evaluators can subjectively assign their personal range of the linguistic variable. Take  $E_j^k$  to indicate the fuzzy possibility value of

evaluator  $k$  towards activity  $i$  under factor  $j$ , and all of the assessment factors will be indicated by set  $S$ , then,

$$E_{ij}^k = (LE_{ij}^k, ME_{ij}^k, UE_{ij}^k), \quad j \in S \quad (5)$$

Since the perception of each evaluator varies according to the evaluator's experience and knowledge, and the definitions of the linguistic variables vary as well, if there are several evaluators in assessment process, this study uses the notion of average value to integrate the fuzzy judgment values of  $m$  evaluators, that is,

$$E_{ij} = (1/m) \otimes (E_{ij}^1 \oplus E_{ij}^2 \oplus \dots \oplus E_{ij}^m) \quad (6)$$

The sign  $\otimes$  denotes fuzzy multiplication, the sign  $\oplus$  denotes fuzzy addition, and  $E_{ij}$  shows the average fuzzy number of the judgment of the decision-maker, which can be displayed by a triangular fuzzy number as follows:

$$E_{ij} = (LE_{ij}, ME_{ij}, UE_{ij}) \quad (7)$$

The preceding end-point values  $LE_{ij}$ ,  $ME_{ij}$ , and  $UE_{ij}$  can be solved by the method put forward by Buckley [4], that is,

$$LE_{ij} = \left( \sum_{k=1}^m LE_{ij}^k \right) / m \quad (8)$$

$$ME_{ij} = \left( \sum_{k=1}^m ME_{ij}^k \right) / m \quad (9)$$

$$UE_{ij} = \left( \sum_{k=1}^m UE_{ij}^k \right) / m \quad (10)$$

- (2) Fuzzy synthetic judgment: The weights of the each risk assessment factor of construction project as well as the fuzzy possibility values must be integrated by the calculation of fuzzy numbers so as to be located at the fuzzy synthetic judgment value (effect-value) of the integral assessment. According to the weight  $w_j$  derived by AHP, the weight vector can be obtained, whereas the fuzzy possibility matrix  $E$  of each of the activities can also be obtained from the fuzzy judgment value of each activity under  $n$  criteria, that is,

$$w = (w_1, \dots, w_j, \dots, w_n)^t \quad (11)$$

$$E = (E_{ij}), \quad \forall i, j \quad (12)$$

From the weight vector  $w$  and fuzzy possibility matrix  $E$ , the final fuzzy synthetic judgment can be conducted, and the derived result will be the fuzzy synthetic judgment matrix  $R$ , that is,

$$R = E \cdot w \quad (13)$$

The sign “ $\circ$ ” indicates the calculation of the fuzzy numbers, including fuzzy addition and fuzzy multiplication. Since the calculation of fuzzy multiplication is rather complex, it is usually denoted by the approximate multiplied result of the fuzzy multiplication, and the approximate fuzzy number  $R_i$  of the fuzzy synthetic decision of each alternative can be shown as follows:

$$R_i = (LR_i, MR_i, UR_i), \quad \forall i \quad (14)$$

$$LR_i = \sum_{j=1}^n LE_{ij} * w_j \quad (15)$$

$$MR_i = \sum_{j=1}^n ME_{ij} * w_j \quad (16)$$

$$UR_i = \sum_{j=1}^n UE_{ij} * w_j \quad (17)$$

- (3) Ranking the fuzzy number: The result of the fuzzy synthetic judgment reached by each activity is a fuzzy number. Therefore, it is necessary that a nonfuzzy ranking method for fuzzy numbers be used for during the project risk judgment for each activity. In other words, the procedure of defuzzification is to locate the Best Nonfuzzy Judgment value (BNJ). Methods of such defuzzified fuzzy ranking generally include mean of maximal (MOM), center of area (COA), and  $\alpha$ -cut [17][34]. To utilize the COA method to find out the BNJ is a simple and practical method, and there is no need to bring in the preferences of any evaluators, so it is used in this study. The BNJ value of the fuzzy number  $R_i$  can be found by the following equation:

$$BNJ_i = [(UR_i - LR_i) + (MR_i - LR_i)] / 3 + LR_i, \quad \forall i \quad (18)$$

According to the value of the derived  $BNJ_i$  for each of the project activities, it ranks the degrees of risk for the project activities and provides a basis for considering the priority of the response to the activities in a construction project.

### 3.FRAMEWORK OF THE SYSTEM

When developing a framework for the DSS, it is important to realize that various tasks must be assigned to either the computer or the user. In other word, it has to be determined which activities are the responsibility of the decision maker (user input) and which are the best handled by the computational system (system requirements)[19]. Based on the procedures mentioned in section above, we developed an integrated system of AHP and FMCDM to perform the assessment of construction project risk. Since iteration of the process is required, a spreadsheet application lends itself as a logic choice for the application tool. Microsoft Excel was selected as the spreadsheet application tool for the decision support

system. The process diagram of AHP and FMCDM for assessing the degree of risk of each activity in this study is shown as Fig 4. Then, the main interfaces of the system are shown as Fig.5 to Fig. 15.

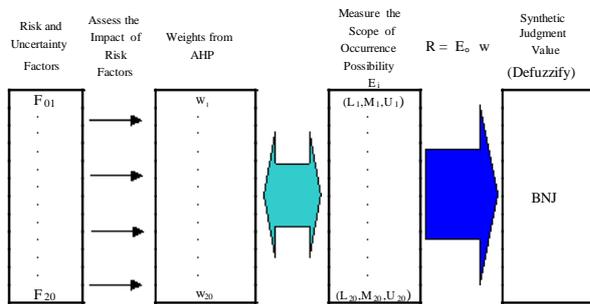


Fig. 4 Diagram of AHP and FMCDM for Assessing the Degree of Risk of Each Activity

	A	B	C	D	E	M	U	V	W	X
1										
2		1	0.2	0.333333	0.1428571	0.057				
3		5	1	3	0.3333333	0.263			C.I.=	0.0395
4		3	0.333333	1	0.2	0.122			lambda_max =	4.1185
5		7	3	5	1	0.558			C.R.=	0.0439
6						1.000				

Fig. 7

	A	B	C	D	E	F	O	X	Y	Z	AA
1											
2		1	7	5	3	7	0.500				
3		0.142857	1	0.3333333	0.2	3	0.075				C.I.= 0.0745
4		0.2	3	1	0.3333333	3	0.125				lambda_max = 5.2960
5		0.333333	5	3	1	5	0.255				C.R.= 0.0665
6		0.142857	0.333333	0.3333333	0.2	1	0.046				

Fig. 5

	A	B	C	D	E	F	G	O	X	Y	Z	AA
1												
2		1	0.2	0.142857	3	0.5	0.333333	0.072				
3		5	1	1	4	2	3	0.283				C.I.= 0.0701
4		7	1	1	4	2	5	0.332				lambda_max = 6.3525
5		0.333333	0.25	0.25	1	0.333333	0.333333	0.052				C.R.= 0.0625
6		2	0.5	0.5	3	1	1	0.138				
7		3	0.333333	0.2	3	1	1	0.123				
8								1.000				

Fig. 8

	A	B	C	D	K	R	S	T	U	V	
1											
2		1	0.333333	3	0.260						C.I.= 0.0194
3		3	1	5	0.633						lambda_max = 3.0387
4		0.333333	0.2	1	0.106						C.R.= 0.0334

Fig. 6

	A	B	C	D	E	M	U	V	W	X	
1											
2		1	0.2	0.333333	3	0.128					
3		5	1	3	5	0.533					C.I.= 0.0671
4		3	0.333333	1	5	0.273					lambda_max = 4.2013
5		0.333333	0.2	0.2	1	0.067					C.R.= 0.0745
6						1.000					

Fig. 9

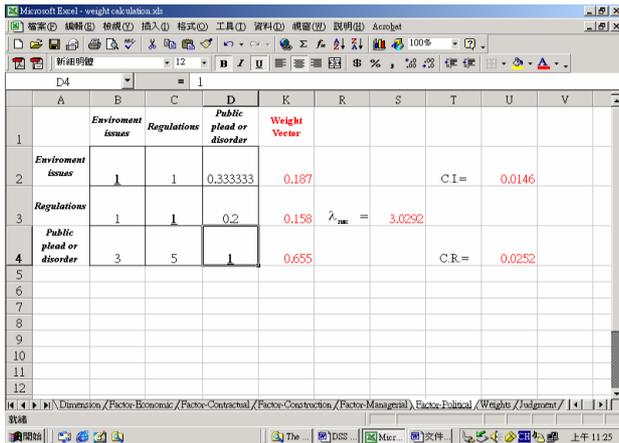


Fig. 10

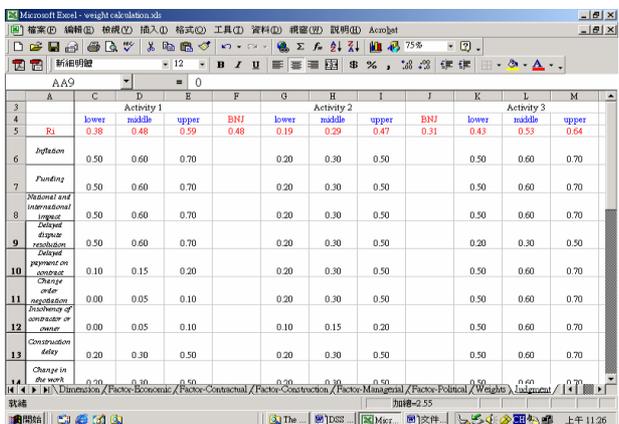


Fig. 11

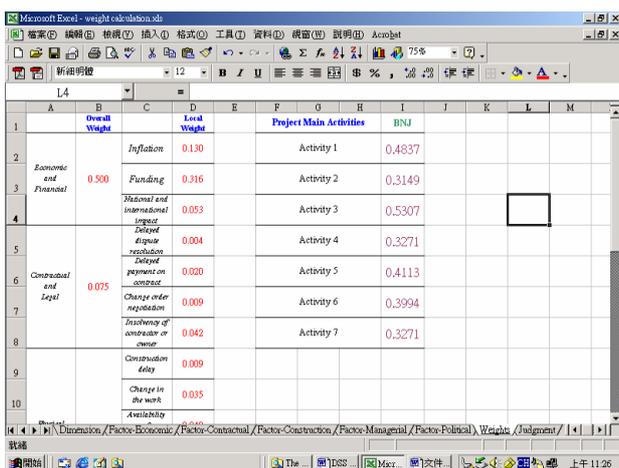


Fig. 12

#### 4.CONCLUSION

General speaking, more preparation in advance will get less loss on operation. Thus, this work provides a systemic model to assess the factors of risk of a

construction project may encounter, and according to the results of assessment to plan the risk management strategies for construction activities. It is helpful to contractor recognize what risk factors he will face and how to plan a risk management strategies when was awarding a large-scale construction contract. The purpose of this study was to develop a scientific framework and computer-based decision support system for the risk assessment of construction project. This work proposes a multi-criteria framework for risk assessment. To deal with the qualitative attributes in subjective judgment, this work employs Analytic Hierarchy Process (AHP) to determine the weights of risk factors. Then, the Fuzzy Multiple Criteria Decision Making (FMCDM) approach is adopted to synthesize the degree of risk of each activity. This process enables decision makers to formalize and effectively solve the complicated, multicriteria and fuzzy/vague perception problem of project risk assessment. An integrated decision support system that combines the AHP method and FMCDM approach to be effective and convenient for assessing the degree of risk by a popular program-EXCEL. It will assist the project managers in making critical decisions during the phase of project contracting and construction.

#### Reference

- [1] Akintoye A. S. and MacLeod M. J., "Risk Analysis and Management in Construction," International Journal of Project Management, 1997,15(1), 131-38.
- [2] Baccarini, D. and Archer, R., "The Risk Ranking of Projects: a Methodology," International Journal of Project Management, 2001, 19, 139-145.
- [3] Bellman, R. E. and Zadeh, L. A., "Decision Making in a Fuzzy Environment," Management Science, 1970, 17(4), 141-164.
- [4] Buckley, J. J. "Ranking Alternatives Using Fuzzy Numbers," Fuzzy Sets and Systems, 1985, 15(1), 21-31.
- [5] Cooper, D. F. and Chapman, C. B., Risk Analysis for Large Project: Models, methods and Cases, Wiley, Chichester, U.K., 1987.
- [6] Chapman, C. and Ward, S. "Estimation and Evaluation of Uncertainty: a Minimalist First Pass Approach," International Journal of Project Management, 2000, 18, 369-383.
- [7] Chapman, R. J., "The Controlling Influences on Effective Risk Identification and Assessment for Construction Design Management," International Journal of Project Management, 2001, 19, 147-160.
- [8] Charoenngam, C. and Yeh, C. Y., "Contractual Risk and Liability Sharing in Hydropower Construction," 1999, 17(1), 29-37.
- [9] Chen, S. J. and Hwang, C. L., Fuzzy Multiple Attribute Decision Making-Method and Applications, Springer- Verlag, New York, 1992.
- [10] Conroy, G. and Soltan, H., "ConSERV, a Project Specific Risk Management Concept," International Journal of Project Management, 1998, 16(6), 353-366.
- [11] Dawood, N. "Estimating Project and Activity Duration: A Risk Management Approach Using Network

- Analysis,” *Construction Management and Economics*, 1998, 16, 41-48.
- [12] Dubis, D., and Prade, H., “Operations on fuzzy numbers” *International Journal of Systems Science*, 1978, 19(6), 613-626.
- [13] Elkjaer, M., “Stochastic Budget Simulation,” *International Journal of Project Management*, 2000, 18, 139-147.
- [14] Hwang, C. L., and Yoon, K., *Multiple Attribute Decision Making: Methods and Applications*, New York: Springer-Verlag, 1981.
- [15] Kangari, R. and Riggs, L.S., “Construction Risk Assessment by Linguistics,” *IEEE Transactions on Engineering Management*, 1989, 36(2), 126-131.
- [16] Kangari, R., “Risk Management Perceptions and Trends of U.S. Construction,” *Journal of Construction Engineering and Management*, ASCE, 1995, 121(4), 422-429.
- [17] Lu, S. T., Hsieh, T. Y., Lee, J. S. and Tzeng, G. H., “A Decision Support System for Planning and Design Tender Selection in Public Buildings,” *Proceedings of the First International Conference on Electronic Business*, Hong Kong, 2001, 215-217.
- [18] Mak, S. and Picken, D. “Using Risk Analysis to Determine Construction Project Contingencies,” *Journal of Construction Engineering and Management*, 2000, 126(2), 130-136.
- [19] McIntyre, C., and Parfitt, M. K., “Decision Support System For Residential Land Development Site Selection Process,” *Journal of Architectural Engineering*, ASCE , 1998, 4(4), 125-131.
- [20] Paek, J. H., Lee, Y. W. and Ock, J. H., Pricing “Construction Risk: Fuzzy Set Application,” *Journal of Construction Engineering and Management*, ASCE, 1993, 119(4), 743-755.
- [21] Raftery, J., *Risk Analysis in Project Management*, London, E&FN Spon, 1994.
- [22] Saaty, T. L. “A Scaling Method for Priorities in Hierarchical Structures,” *Journal of Mathematical Psychology*, 1997, 15(3), 234-281.
- [23] Saaty, T. L. *The Analytic Hierarchy Process*, New York : McGraw-Hill, 1980.
- [24] Smith, G. R. and Bohn, C. M., “Small to Medium Contractor Contingency and Assumption of Risk,” *Journal of Construction Engineering and Management*, 1999, 125(2), 101-108.
- [25] Tah, J. H. M. and Carr, V., “Information Modeling for Project Risk Analysis and Management,” *Engineering, Construction and Architectural management*, 2000, 17(2), 107-119.
- [26] Tah, J. H. M. and Carr, V., “Knowledge-Based Approach To Construction Project Risk Management,” *Journal of Computing in Civil Engineering*, ASCE, 2001, 170-177.
- [27] Thompson, P. A. and Perry, J. G., *Engineering Construction Risk: A Guide to Project Risk Analysis and Risk Management*, Thomas Telford, London, 1993.
- [28] Titarenko, B. P. “Robust Technology’ in Risk Management,” *International Journal of Project Management*, 1997 15(1), 11-14.
- [29] Tummala, V. M. R., Leung, H. M., Mok, C. K., Burchett, J. F. and Leung, Y.H., “Practices, Barriers and Benefits of Using Risk Management Approaches in Selected Hong Kong Industries,” *International Journal of Project Management*, 1997, 15(5), 297-312.
- [30] Wideman, R. M., “Risk Management, Project Management Journal,” 1986, 17(4), 20-26.
- [31] Ye, Sudong and Tiong, L. K. R., “NPV-At-Risk Method in Infrastructure Project Investment Evaluation,” *Journal of Construction Engineering and Management*, 2000, 126(3), 227-233.
- [32] Zadeh L. A., *Fuzzy sets, Information and Control*, Vol. 8, No.2, 338-353, 1965.
- [33] Zadeh, L. A. “The Concept of A Linguistic Variable and Its Application to Approximate Reasoning, Parts 1, 2 and 3,” *Information Sciences*, 1975, 8(2), 199-249; 8(3), 301-357; 9(1), 43-80.
- [34] Zhao, R. and Govind, R. “Algebraic Characteristics of Extended Fuzzy Numbers,” *Information Science*, 1991, 54(1), 103-130.
- [35] Zhi, H. “Risk management for overseas construction project,” *International Journal of Project Management*, 1995, 13(4), 231-237.

# An On-Line Personalized Promotion Decision Support System for Electronic Commerce

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## Abstract

With the development of the Internet and Electronic Commerce (EC), enterprises have overcome the space and time barriers and are now capable of serving customers electronically. However, it is a great challenge to attract and retain the customers over Internet. One approach is to provide the responsive personalized service to satisfy the customer demand and promote sales at the first time. Hence, in this paper, we propose a decision support system which develops best promotion products based on combinations of different marketing strategies, pricing strategies, and customer behaviors evaluated in terms of multiple criteria. Data mining techniques are utilized to help the business discover patterns to develop on-line sales promotion products for each customer for enhancing customer satisfaction and loyalty.

The proposed system consists of four components: (1) establishing marketing strategies, (2) promotion pattern model, (3) personalized promotion products, and (4) on-line transaction model. A simple example is given to illustrate the implementation and application of proposed decision support system.

**Keywords:** Decision support systems, electronic commerce, personalized promotion, data mining

## 1. Introduction

The growth of the internet and the expansion of on-line shopping have forced traditional business to rethink over their marketing promotion programs because on-line shopping changes customer behavior dramatically. On-line personalized promotion provides business returns based on its ability to retain current customers and increase the value of customers [8].

On-line personalization of sales promotions can be executed at various levels of sophistication. There are two major approaches to provide personalized information [13]. In the content based approach, it provides items that are similar to what the user has favored in the past. In the collaborative filtering approach, it identifies other users that have showed similar preference to the given users and provides what they would like. The purpose of this research is to well formulate marketing strategies for offering customers promotions related to product categories they have

purchased.

Besides, the effectiveness of promotions can be expected to increase if customers receive promotions that most attract them. Another purpose of this research is to study how to use data mining techniques to analyze historical on-line purchase data of a large group of customers to characterize all customers, customer cluster, and individual customers' shopping behavior. Accordingly, an intelligent on-line personalized promotion decision support system is proposed in this paper.

Simply stated, data mining refers to extracting knowledge from large amounts of data [4]. Kleissner [7] defined that data mining is a new decision support analysis process to find buried knowledge in corporate data and deliver understanding to business professionals. Hence, decision makers can quickly and correctly make decisions via data mining analysis.

The organization of the paper is as follows. Section 2 proposes an intelligent on-line personalized promotion decision support system. It is classified into five parts: (1) system architecture, (2) establishing marketing strategies, (3) creating a promotion patterns model, (4) generating personalized promotion products, and (5) proceeding with on-line transaction model. Finally, we conclude the paper and present directions for future research in Section 3.

## 2. An Intelligent On-line Personalized Promotion Decision Support System

In this paper, we present an intelligent on-line personalized promotion decision support system, which uses the data mining techniques to help the business discover suitable promotion products for each individual customer.

### 2.1 System architecture

Figure 1 shows the architecture of the system, which consists of the following components: (1) marketing strategies, (2) promotion patterns model (3) personalized promotion products, and (4) on-line transaction model. Each component of the proposed system is described in details as follows.

### 2.2 Marketing strategies

The marketing strategies include promotion strategies and the pricing strategies with business life cycle.

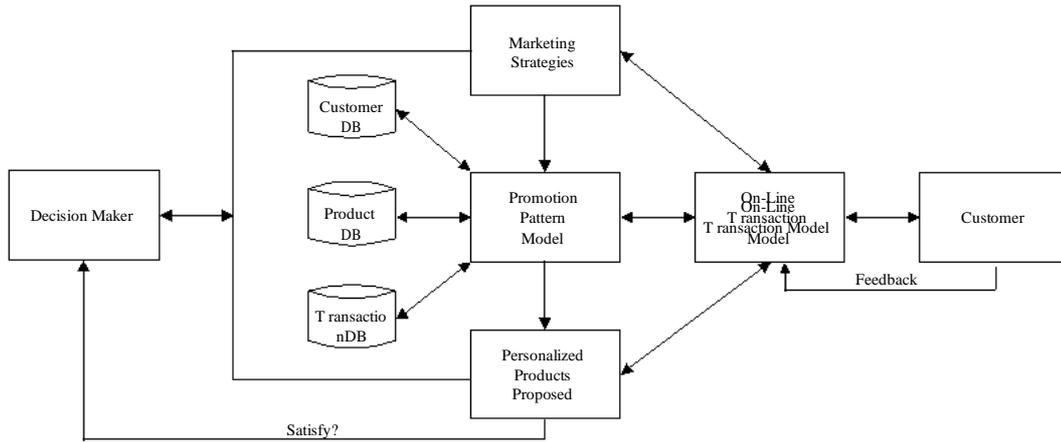


Figure 1. An intelligent on-line personalized promotion decision support system

### 2.2.1 promotion strategies

Most scholars believe that sales promotion can give the promoted objects immediate incentives and excite their interest. Davis [3] considered that sales promotion strengthens the marketed effect and increases the sales volume in short-term. Some other scholars subsumed the objects of sales promotion under the definition of promoted activities. Hence the promoted activities include customer promotion, trade promotion, and sales-force promotion.

In this paper, we focus on customer promotion in Internet. According to the classification of on-line customer promotion proposed by Hsu [5], on-line promotion models can be divided into cash discount, commodity presentation, and rewards drawing activities. Promotion models are listed in Table 1. Here, in our proposed system, sales promotion strategies including general promotion, cross-selling, and up-selling strategies are presented in Table 2. The three strategies utilize two promotion models, which are cash discount and commodity presentation.

Table 1. Promotion models [5]

Promotion model		Promotion manner
Cash discount	Universal price discount	Price-offs
		Price discount
	Differential price discount	Quality discount
		Total discount
Commodity presentation	Same kind Commodity presentation	Bonus packs
	Different kind Commodity presentation	Premiums
		Bundling
Rewards drawing activities		Trading stamps and sweepstakes

### 2.2.2 pricing strategies with business life cycle

For the pricing strategy, we define the promoted price based on two factors. One is the price strategy for each stage in business life cycle, and the other is the original price of product. In addition, the promoted price will be adjusted dynamically with time; that is to say, when the business situation or the product profit changes, the system will automatically, on the basis of the two factors, to refresh a new promoted price. First, we propose an approach which assesses business life cycle based on the capital growth ratio, employee growth ratio, and sales volume growth ratio and sets up the pricing strategies for each stage. The idea comes from the methods presented by Chow [2] and Smith et al.[11]. The pricing strategy for each stage of business life cycle strategy is shown in Table 3. It divides the business life cycle into four stages including introduction, growth, maturity, and decline stages. The value of growth ratio differentiates at each stage in the business life cycle. The growth ratio is defined by Chow [2] as the following formula.

$$R_i = \frac{G_i}{|G_{i-1}|}, \quad G_i = \frac{S_i - S_{i-1}}{S_{i-1}} \times 100\%$$

where  $R_i$  is the  $i$ -th period growth ratio,  $G_i$  is the  $i$ -th period growth rate, and  $S_i$  is the  $i$ -th period value of capital, employee and sales volume.

Next, we hope to consider two factors, pricing strategy for each stage and product price, in finalizing the final promoted price. Generally, the product price depends on the desired profit for business. Similarly, the promoted price should be adjusted according to the final profit that the business expects to yield. Here, let the final profit be  $P$ , the cost be  $C$  and the final promoted price be  $PP$ . Then  $PP = C(1+P)$ .

**Table 2. Proposed sales promotion strategies**

Strategy	Product categories	Promotion condition	Price manner	Applied technique
General promotion	† Best-selling	† Purchased quantity † Purchased total amount	† Price discount	† Cross analysis
	† Worst-selling			
Cross-selling	† Seasonal product † Festival product	† Bundling † Purchased total amount		† Association mining † Sequential pattern mining
Up-selling	† Association product † Sequential product	† Bundling † Purchased total amount	† Cross analysis	

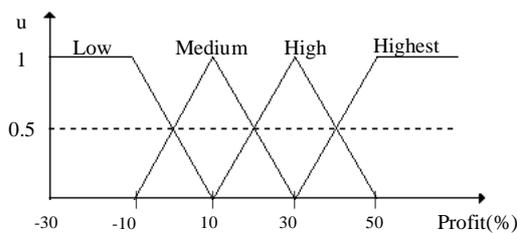
**Table 3. Pricing strategy for each stage of business life cycle**

Business life cycle	Introduction	Growth	Maturity	Decline
Characteristic				
Growth Ratio (Capital, Employee and Sales Volume)	$R_i \geq 2$	$2 > R_i \geq 1$	$1 > R_i \geq 0$	$R_i < 0$
Price strategy for each stage	Low	Highest	High	Medium

In this research, by using a fuzzy set theory [13], an approach is proposed to help the business to decide the final promoted price. Two steps involve in the decision of final promoted price. One is to define the membership function for the profit, and the other is to utilize the fuzzy rule-based inference to obtain the final profit.

(1) defining the membership function for the profit

In fuzzy logic, a fuzzy set A on universe X is defined by the ordered pair  $(x, \mu_A(x))$ , where x is the object on X, and  $\mu_A(x)$  is called the membership function of A. The membership function can be any value in the range of [0.0, 1.0]. Now, we define the membership function for profit as shown in Figure 2.



**Figure 2. Membership function for profit**

(2) utilizing the fuzzy rule-based inference to obtain the final profit

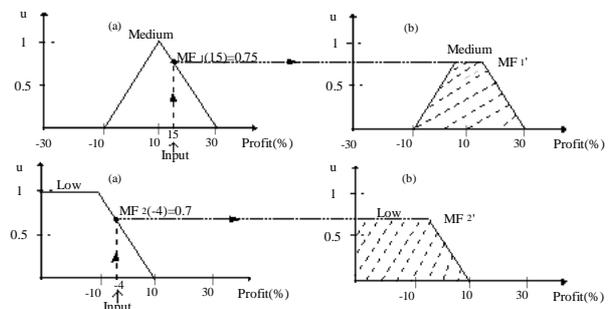
In this step, the promoted price will be obtained by combining the following two fuzzy rules. Firstly, assuming that a product ‘A’ has a profit of 15% and its cost is C. Secondly, assuming that the business life cycle stage is ‘Introduction’ and the pricing strategy for this stage is ‘Low.’ Therefore, the first fuzzy rule (say,  $MF_1$ ) is “if the profit of product ‘A’ is Medium then the final profit is Medium,” according to the membership function for profit of Figure 2. Then, the second fuzzy rule (say,  $MF_2$ ) is “if business profit is Low then the final profit is Low.”

Finally, an output value can be generated from a membership function merged from the two fuzzy rules

mentioned above. The inference process consists of three basis steps and one optional step [6]. The first three steps are fuzzy matching, inference, combination, and the optional one is defuzzification.

(a) fuzzy matching step

Firstly we define the fuzzy matching function as  $MF(p)=d$ , where  $MF()$  is a fuzzy membership function such as  $MF_1$  or  $MF_2$ , the original product profit p is an input of  $MF()$ , and the matching degree d is an output of  $MF()$ . We assume that two inputs are 15 and -4 respectively. Figure 3(a) illustrates that the outputs 0.75 and 0.7 are obtained by the mentioned two fuzzy rules  $MF_1$  and  $MF_2$ , respectively.



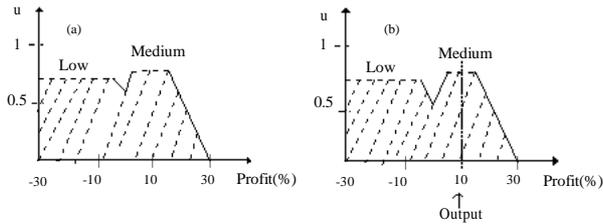
**Figure 3. (a) Fuzzy matching step (b) inference step**

(b) inference step

After the fuzzy matching step, we will calculate the rule’s conclusion based on its matching degree. Figure 3(b) using the clipping method, the matching degree 0.75 and 0.7 suppress the membership functions  $MF_1$  and  $MF_2$  into  $MF_1'$  and  $MF_2'$ .

(c) combination step

The step combines the conclusion inferred by all fuzzy rules into a final conclusion. This is illustrated in Figure 4(a) for combining two fuzzy conclusions  $MF_1'$  and  $MF_2'$  using the clipping method.



**Figure 4. (a) Combining fuzzy conclusions inferred by the clipping method (b) the result of MOM defuzzification.**

(d) defuzzification step

For the reason that we need a crisp output, an additional step is used to convert a fuzzy conclusion into a crisp one. This step is called defuzzification. The Mean of Maximum (MOM) method is used to calculate the average of all variable values with maximum membership degrees. Figure 4(b) shows the result of applying MOM defuzzification to a combined fuzzy conclusion. The value of final conclusion is 10%; that is, the final profit is 10%. Therefore, in this example, the final promoted price is  $C(1+10\%)$ .

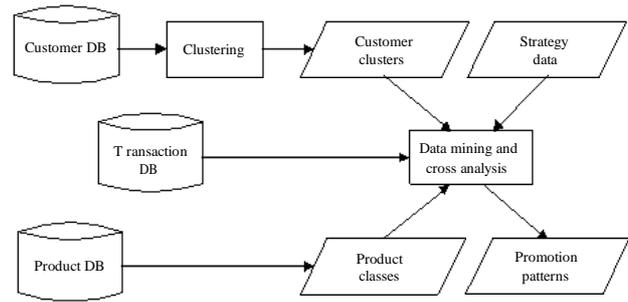
With the proposed price strategy, we have three opportunities for promotion discount.

- (1) general discount : The cross-selling and up-selling products will obtain the price discount based on the strategies above.
- (2) purchased quantity discount : The new, best-selling, worst-selling, seasonal or festival products in general promotion will obtain the price discount when the purchased quantity is greater than or equal to a decision-maker specified minimum quantity threshold.
- (3) purchased total amount discount : The customer will obtain the price discount when the purchased total amount is greater than or equal to a decision-maker specified minimum total amount threshold.

### 2.3 Promotion pattern model

In this stage, we propose a promotion pattern model which is illustrated in Figure 5. It utilizes data mining techniques and cross analysis to carry out the promotion strategies, as discussed in Section 2.2, from product, customer, and transaction databases. The purpose is to assist the business in discovering appropriate promotion patterns.

For the easy management and analysis consideration, all the products are classified into several categories in advance. For example, suppose that there are fifteen products, and all products are classified into five classes A, B, C, D, and E. The outcome is listed in Table 4. The product with Item\_ID '1' is classified into the class 'A.'



**Figure 5. Promotion pattern model**

**Table 4. Product classes**

Item ID	Class	Brand	Price	Cost	Status
1	A	IBM	\$740	\$643	-
2	A	ACER	\$1,250	\$937	-
3	A	ACER	\$1,567	\$1,160	New
4	B	TWINHEAD	\$2,293	\$1,700	-
5	B	IBM	\$1,829	\$1,460	-
6	C	EPSON	\$83	\$67	-
7	C	HP	\$153	\$127	-
8	C	HP	\$223	\$157	New
9	D	EPSON	\$183	\$153	-
10	D	HP	\$110	\$100	-
11	D	HP	\$170	\$143	-
12	E	LEMEL	\$87	\$70	-
13	E	PLEXTOR	\$100	\$83	-
14	E	PLEXTOR	\$200	\$153	New
15	E	RITEX	\$0.33	\$0.30	-

#### 2.3.1 data mining for customer database

Market segmentation divides a larger market into submarkets based upon different needs or product preferences. Clustering analysis is one of the most frequently used method for segmenting a market.

(1) clustering

All products were classified into five classes earlier. However, we don't know the exact number of customer categories. Hence, clustering technique becomes the choice. Here, we will utilize the automatically clustering feature of Adaptive Resonance Theory Network (ART) to cluster customers. It uses customers' demographic and behavior to segment customers. In other words, all the customers who are in the same cluster have the similar demographic and behavior.

ART is an unsupervised learning network developed by Carpenter and Grossberg [1]. It is capable of determining the number of clusters through progressive adaptation.

(a) ART allows a training example to modify an existing cluster only if the cluster is sufficiently close to the example; otherwise a new cluster is formed to handle the example.

(b) ART can determine when a new cluster should be formed by using a "Vigilance parameter" as a threshold of similarity between patterns and

clusters.

For example, there are five customers data shown in Table 5. Since the inputs of ART should be binary values, we must design the corresponding values for the inputs of the example in advance. Here, some discretization techniques [4] are used to divide customers' attributes Income, Age, and Total amount into the intervals labeled as Low, Medium, and High. Take attribute Income as an example. The Low interval is defined below 1000, and can be coded as "00." The Medium interval is defined between 1000 and 1700, and can be coded as "01." The High interval is defined above 1700, and can be coded as "11." Similarly, attributes Age and Total amount are discretized and encoded in the same way as in Table 6.

**Table 5. The customers data**

Customer ID	Name	Income	Age	Sex	Total amount
111	Sam	1,800	35	M	400
122	Mary	8,00	22	F	2,000
123	Annie	1,300	27	F	1,200
113	David	1,900	52	M	500
133	Jacky	1,400	55	M	1,500

**Table 6. Discretizing and encoding attributes as an ART input**

Attribute	Range		
	Code		
Income	<1,000	1,000-1,700	>1,700
	00	01	11
Age	<30	30-50	>50
	00	01	11
Sex	M	F	
	1	0	
Total amount	<300	300-1,000	>1,000
	00	01	11

According to the discretization and encoding method, five vectors corresponding to the five customers' data shown in Table 5 can be obtained as follows.

Attribute sets = {Income, Age, Sex, Total amount}  
 Sam = {11, 01, 1, 01}  
 Mary = {00, 00, 0, 11}  
 Annie = {01, 00, 0, 11}  
 David = {11, 11, 1, 01}  
 Jacky = {01, 11, 1, 11}

(2) customer clusters

Set the Vigilance parameter as 0.5, three clusters can be generated by ART. Mary and Annie belong to the first cluster, Sam and David belong to the second cluster, and the third cluster contains Jacky. Table 7 displays the cluster label and the corresponding customer ids. For example, the customer numbered 113 belongs to the cluster label of A.

**Table 7. Clusters of customers**

Cluster	Customer ID
A	{111, 113}
B	{122, 123}
C	{133}

**2.3.2 data mining and cross analysis for transaction database**

The above section discussed that the business divides customers into several different clusters based on a clustering technique. Therefore, we can take that as a basis to provide different promotions for different clusters. In this section, we will progress towards the data analysis of transaction database by data mining and cross analysis in order to find out different promotion fitting for the different clusters.

(1) data mining

Here, we will utilize association rule mining and sequential pattern mining respectively. Then we discover association products and sequential products which are purchased together and purchased in sequence respectively.

(a) association mining

It can be found that what kinds of products are purchased at the same time through association rules mining. In the paper, an association mining method [9] is used to find out the affinity of products purchased together from the transaction data of all customers. At the same time, the association mining method can also be applied to each customer cluster and individual customer to extract the purchasing patterns for each customer cluster and each individual customer.

Consider the transaction database in Table 8. Assume that the minimum support is 4. The association products {2, 7} and {13, 15} are obtained for all customers. That means that all the customers tend to buy items 2 and 7 together or buy items 13 and 15 together. From Table 8, customer 113 belongs to customer cluster A. By association mining on customer cluster "A," we discovered that the customers of this cluster tend to buy items 13 and 15 together. Similarly, applying association mining to each individual customer (say customer 113), we found that the customer loved to buy items 13 and 15 together as well. All the association product patterns for three customer categories (all customers, customer cluster and individual customer) in this example are shown in Table 9.

(b) sequential pattern mining

It can be found that what kinds of products are purchased after buying some item through sequential patterns mining. In the paper, sequential pattern mining methods [9] are used to find out the products frequently purchased in sequence over time from the transaction data of all customers. At the same time, the sequential pattern methods can also be applied to each customer cluster and individual customer to extract all the sequential purchase patterns.

**Table 8. Transaction data**

TID	Itemset	Customer ID	Cluster
1	{2,7,11}	111	A
2	{9,10,12}	111	A
3	{2,5,7}	112	A
4	{7,13,15}	113	A
5	{4,10,13,15}	113	A
6	{3,13}	121	B
7	{2,5,7}	122	B
8	{1,8,12,13}	122	B
9	{2,13,15}	123	B
10	{15}	123	B
11	{2,7}	131	C
12	{12}	131	C
13	{2,4,9}	132	C
14	{10,13}	132	C
15	{2,7,11,14}	133	C

**Table 9. Association product patterns for three customer categories**

All customers	{2,7}{13,15}
Customer cluster A	{13,15}
Individual customer (Customer 113)	{13,15}

Consider the transaction database in Table 8. Assume that the minimum support is 2. The sequential product patterns {2, 12} and {7, 12} are obtained for all customers. That means that all the customers have a trend to buy item 12 after buying item 2 and to buy item 12 after buying item 7. From Table 8, customer 113 belongs to customer cluster A. Similarly, by sequential pattern mining on customer cluster A, we found that the customers of this cluster tend to buy item 10 after buying item 7. All the sequential product patterns are shown in Table 10.

**Table 10. Sequential product patterns for three customer categories**

All customers	{2,12}{7,12}
Customer cluster A	{7,10}
Individual customer (Customer 113)	-

**(2) cross analysis**

We will utilize the cross analysis for best and worst selling and up-selling strategy. The best-selling and worst-selling products can be found based on the statistical analysis. The upgraded products can be found with up-selling strategy.

**(a) statistical analysis**

For each product class, cross analysis can be firstly carried out on the product data (as shown in Table 4) and transaction data (as shown in Table 8) of each kind of customer category for acquiring the best-selling (e.g., the ratio of sales volume is more than 50%) and worst-selling (e.g., the ratio of sales volume is 0%) products.

Here, cross analysis will not be carried out on

the products with the status labeled as “new” because no sufficient transaction data can be analyzed for those new products.

**(b) up-selling strategy**

A technique is applied to the association, sequential, and best-selling products for increasing sales of each customer category. For example, an item set {2, 7} is an association product pattern mined for the category of all customers. Up-selling analysis is firstly applied to item 2 which belongs to product class A. Then, item 3 will be obtained for up-selling because items 2 and 3 belong to the same class A and have the same characteristic.

**Table 11. Best-selling and worst-selling of all product classes for all customers, customer cluster A and customer 113**

Product class	All customers		Customer cluster A		Individual customer (Customer 113)	
	Best selling	Worst selling	Best selling	Worst selling	Best selling	Worst selling
A	{2}	-	{2}	{1}{3}	-	-
B	{4}{5}	-	{4}{5}	-	{4}	-
C	{7}	{6}	{7}	{6}	{7}	-
D	{10}	-	{10}	-	{10}	-
E	-	-	-	-	{13}{15}	-

Here, we use attribute “brand” as the characteristic of up-selling case. In the proposed up-selling strategy, we can consider combined items for up-selling if an up-selling item is combined to other items belonging to an extracted association product pattern. Therefore, the item set {3, 7} is also an up-selling product. All up-selling products are listed in Table 12 for each kind of customer categories.

**2.4 Personalized promotion products proposed**

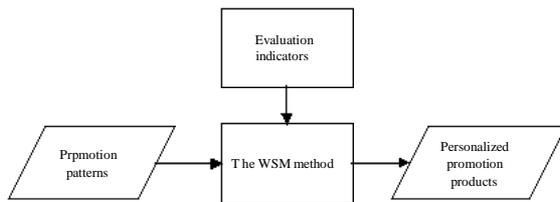
The proposed system will generate many promotion products such as those in Table 12, and we regard them as candidate promotion products. However, not all the candidate products should be offered for promotion. Some evaluation should be done for ordering all of the candidate promotion products. In this paper, WSM (Weighted Sum Model) is used for ranking. WSM is a multi-criteria decision making method.[12] Figure 6 illustrates the model of personalized promotion products proposed.

**2.4.1 promotion patterns**

Promotion patterns are discovered from product, customer, and transaction databases with data mining techniques. Table 12 shows the promotion products.

**Table 12. Promotion all product classes for all customers, customer cluster A, and customer 113**

All customers	Association products	{2,7}{13,15}	Up-selling products	{3}{3,7}{8}{2,8}{3,8}{14}{14,15}
	Sequential products	{2,12}{7,12}		{3}{3,12}{8}{8,12}
	Best-selling products	{2}		{3}
		{4}		-
		{5}		-
		{7}		{8}
Worst-selling products	{10}	{11}		
Customer cluster A	Association products	{13,15}	Up-selling products	{14}{14,15}
	Sequential products	{7,10}		{8}{11}{8,10}{7,11}{8,11}
	Best-selling products	{2}		{3}
		{4}		-
		{5}		-
		{7}		-
Worst-selling products	{10}	{11}		
Individual customer (Customer 113)	Association products	{13,15}	Up-selling products	{14}{14,15}
	Sequential products	-		-
	Best-selling products	{4}		-
		{7}		-
		{10}		{11}
		{13}		{14}
Worst-selling products	{15}	-		



**Figure 6. The model of personalized promotion products proposed**

#### 2.4.2 evaluation indicators

To evaluate the candidate products, we propose three evaluation indicators which are profit, customer satisfaction, and success indicators. All these indicator values should be first normalized by scaling its values to a small specified range, such as 0.0 to 1.0.

##### (a) profit indicator

Making money is the primary goal for the businesses. Therefore, they hope the promotion products with high profit should have a high priority when the products are promoted. For this reason, the profit should be included as an evaluation indicator.

##### (b) customer satisfaction indicator

Along with the customer relationship management (CRM) becoming more and more important recently, the customer satisfaction must be subsumed. The manner for evaluating customer satisfaction is to ask the customer whether they are satisfied with the promoted manners, including the product bundling, product price, and so on. The customer will be asked to carry out an evaluation after purchasing is made. The evaluation score is obtained as a feedback from the customer for

measuring the effectiveness of each promotion product.

##### (c) success ratio indicator

This indicator is used to estimate the acceptance ratio of promotion. The success ratio is defined as follows.

Success ratio = the number of promotions accepted / the number of promotions proposed

#### 2.4.3 the WSM method

We will calculate the score of each candidate promotion product by utilizing the WSM method to rank them and obviate those products with low scores. If there are  $m$  candidate promotion products and  $n$  indicators, then the WSM score of each product can be calculated as follows [12]:

$$A_{\text{WSM-score}} = \max_i \sum_{j=1}^n a_{ij} w_j, \text{ for } i = 1, 2, \dots, m, \quad (1)$$

where  $a_{ij}$  is the  $j$ -th actual indicator value of the  $i$ -th candidate promotion product and  $w_j$  is the importance of the  $j$ -th indicator.

We assume the weights of the three indicators are 0.2, 0.5, and 0.3, respectively. After applying the WSM method, the WSM score are showed in Table 13.

#### 2.4.4 personalized promotion products

After all the WSM scores for candidate promotion products, a filtering process follows.

Take the products in Table 13 and assume 0.5 is the filtering threshold. Finally, the final ranking of price discount promotion products is :  $\{11\} > \{14\} > \{8, 10\} = \{10\} > \{5\} > \{3, 7\} > \{2, 8\} = \{2\} > \{2, 7\} > \{7\}$ ; that is,

**Table 13. Each indicator score and final score of candidate promotion products**

Candidate promotion products	Profit indicator	Customer satisfy indicator	Success ratio indicator	Final score	
General discount products	{2,7}	0.27	0.5	0.7	0.51
	{13,15}	0.15	0.5	0.7	0.49
	{3}	0.35	0.5	0.3	0.41
	{8}	0.4	0.2	0.8	0.42
	{3,7}	0.28	0.5	0.8	0.55
	{2,8}	0.37	0.5	0.7	0.53
	{3,8}	0.38	0.4	0.5	0.43
	{14}	0.3	0.8	0.7	0.67
	{14,15}	0.2	0.5	0.4	0.41
	{2,12}	0.27	0.4	0.5	0.40
	{7,12}	0.2	0.3	0.7	0.40
	{3,12}	0.28	0.2	0.1	0.19
	{8,12}	0.3	0.2	0.2	0.22
	{11}	0.18	0.9	0.9	0.76
	{7,10}	0.15	0.3	0.6	0.36
	{8,10}	0.25	0.8	0.7	0.66
{7,11}	0.19	0.5	0.4	0.41	
{8,11}	0.29	0.1	0.5	0.26	
Purchased quantity discount	{2}	0.33	0.5	0.7	0.53
	{4}	0.35	0.4	0.3	0.36
	{5}	0.25	0.7	0.6	0.58
	{7}	0.2	0.5	0.7	0.50
	{10}	0.1	0.8	0.8	0.66
	{6}	0.2	0.2	0.8	0.38
	{13}	0.2	0.5	0.3	0.38
	{15}	0.1	0.5	0.7	0.48

customer 113 will obtain the price discount when he purchases the above products. He will obtain the general discount when he purchases general discount products; moreover, customer 113 will also obtain the purchased quantity discount when his purchase quantity is greater than or equal to a decision-maker’s specified minimum quantity threshold.

**2.5 On-Line transaction model**

Whenever a customer logons to the proposed system, the on-line transaction model is provided, illustrated as in Figure 7. In the model, the system responses immediately to a legal customer when he is in one of the three user statuses: “enter system,” “select a product,” and “shell out.” The response draws forth the corresponding responsive strategy according to which status the customer is.

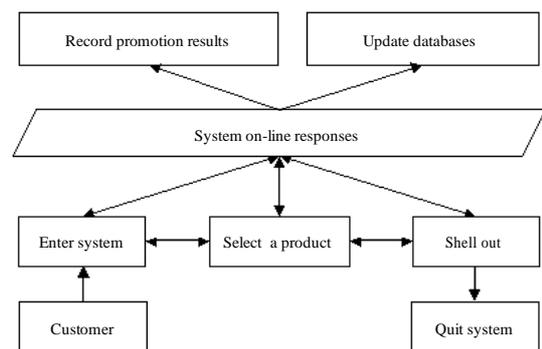
Finally, when a customer quits the system, it will update related database and record the promoted result for calculating success ratio as a basis to enhance the proposed on-line personalized promotion’s effectiveness.

**3. Conclusions and Future Work**

In this paper, we mentioned that the development of Internet has shortened the distance between business and customers. However, it is a bigger challenge that business will face because there are more competitors in Internet than in traditional market, and the customers’ loyalty is so low that it is a difficult problem for a business to attract and retain customers. Traditional mass marketing is no longer suitable; the business must

change to one-to-one marketing so as to provide personalized promotion products for each customer.

Hence, in this paper, different promotion products are proposed for different customers. We present a decision support system to assist business intelligently developing on-line promotion products suitable for each customer. The main concept of the system is that business can utilize data mining techniques to find out effective promotion products based on marketing strategies, pricing strategies, and customers’ purchasing behaviors, where customers may refer to all customers, customer clusters, or an individual customer. Best promotion products are



**Figure 7. On-line transaction model**

**Table 14. On-line responsive strategies**

Customer status	System on-line responsive strategies
Enter system	Select personalized promotion products
Select a product	Select associated products Select discount data for the amount
Shell out	Select discount data for the total

developed after all candidate promotion products are evaluated in terms of multiple criteria. It can increase customer satisfaction and loyalty and finally achieve the goal of strengthening business competitiveness. The system consists of four components: (1) marketing strategies, (2) promotion pattern model, (3) personalized promotion products, and (4) on-line transaction model.

In the future, we shall develop this decision support system and experiment on it in real world to achieve the goal of supporting e-business. In addition, it involves many kinds of techniques in our research. We will continue to devote to the improvement of the techniques later in order to shorten system's response time and then promote its effectiveness.

## References

- [1] Carpenter, G.A. and Grossberg, S., "The ART of adaptive pattern recognition by self-organizing neural network," *IEEE Computer*, Vol. 21, No. 3, pp.77-88, 1998.
- [2] Chow, Wayne S., *Marketing Management*, Best Wise, 1998.
- [3] Davis, K. R., *Marketing Management*, John Wiley & Sons, 1981.
- [4] Han, J and Kamber, M., *Data Mining: Concepts and Techniques*, Morgan Kaufmann Publishers, 2001.
- [5] Hsu, C. H., *Study of Sales Promotion Models on the Internet*, Master thesis, [Department of Information Management](#), National Sun Yat-sen University, 1998.
- [6] Yen, J. and Langari, R., *Fuzzy Logic: Intelligent, Control, and Information*, Prentice Hall, 1998.
- [7] Kleissner, C., "Data mining for the enterprise," *Proceedings of the 31th International Conference on System Science*, Hawaii, pp.295-304, 1998.
- [8] Peppers, D. and Rogers, M., "A new marketing paradigm: share of customers, not market share," *Planning Review*, Vol. 23, No. 2, pp.14-18, 1995.
- [9] Agrawal, R. and Srikant, R., "Fast algorithms for mining association rules," *Proceedings of the 20th International Conference on Very Large Databases*, Santiago, Chile, Sep. 1994.
- [10] Agrawal, R. and Srikant, R., "Mining Sequential Pattern," *Proceedings of the 11th International Conference on Data Engineering*, Taiwan, pp.3-14, 1995.
- [11] Smith, K. G., Mitchell, T. R. and Summer, C. E., "Top level management priorities in different stages of the organizational life cycle," *Academy of Management Journal*, Vol. 28, No. 4, pp. 799-820, 1985.
- [12] Triantaphyllou, E., *Multi-Criteria Decision Making Methods: A Comparative Study*, Kluwer Academic Publishers, 2000.
- [13] Yu, P. S., "Data Mining and Personalization Technologies," *Proceedings of the 6th International Conference on Database Systems for Advanced Applications*, pp. 6-13, 1999.
- [14] Zadeh, L.A., "Fuzzy sets," *Information and Control*, Vol.8, No.3, pp338-353, 1965.

# Efficiency Increase of Export On-Line Systems by Applying Multiple Criteria Decision Support Systems

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## Abstract

Within the frame of E-Commerce and Internet literature, decision support systems have drawn the attention of researchers from a wide spectrum of disciplines. Decision Support Systems can play a critical role, in export decision situations. This paper examines various on-line systems to help execute export business. A variety of export on-line systems have been analyzed to determine which export processes are being supported online. The results of this study provide useful insight for creating ones own Multiple Criteria On-Line Export Decision Support System (EDSS).

Theoretical and practical aspects of decision support systems in electronic commerce were dealt with in various research papers by D. G. Conway et al. (2000), R. Debreceny et al. (2002), F. Ramos et al. (2002), R. Kohlu et al. (2001), and others.

An analysis of e-commerce and on-line decision support systems that were developed by researchers from various countries assisted the authors to create one of their own Multiple Criteria On-Line Export Decision Support System (EDSS). EDSS differs from others in its use of new multiple criteria analysis methods as were developed by the authors.

International trade is an information business. Technological innovations mainly through changes in the availability of information and communication technology combined with calculators, analyzers, decision support, expert and e-commerce systems have been provided by a variety of new services that have been developed from the international trade sector.

International trade Web sites contains a variety of e-commerce systems [1] [2] [3] [4]. Various purposes export software can be used by the on-line regime.

Web sites with various purposes for International Trade contains a variety of calculators: Complete Export

Pricing Calculator [7], Import Calculator [8], Exposure Fee Calculator [9], Interest/Loan Payment Calculator [10], etc.

Web sites might also contain various purpose analyzers [3] [4] [11] which help customers to analyze various situations.

Various expert systems (Expert System for the Application of Import and Export Regulations, Trading Expert System, Business Valuation [1], Business Consultant [12], etc.) can be found on Web sites.

The major players in international trade Web sites can find various purpose decision support systems. That is, Export Analysis Tools and Decision Support System, Logistics Solution (export, dispatch, freight and import), Alternative Resource Base for Forest-Based Export Industries, Wine Producers Who Wish to Export their Products Overseas, State of the Art Decision Support System (GarmentSoft) [13], etc.

Above Web-based Systems for Export are seeking to find out how to make the most economic decisions, and most of all these decisions are intended only for economic objectives. Alternatives under evaluation have to be evaluated not only from the economic position, but take into consideration qualitative, technical, risk and other characteristics as well. Alternative solutions allow for a more rational and realistic assessment of economic, technical, qualitative conditions and traditions and for more satisfaction of different customer requirements. Therefore, applying multiple criteria decision support systems may increase the efficiency of e-business.

The models of gravity, econometrics, portfolio theory and multiple criteria analysis, etc. are used for the analysis of export and the forecast of its development trends. Depending on the subject and goals of the research, as well as the amount and objectivity of the available data, it is believed to be reasonable to use different models of export analysis.

Most of the world's countries use gravity models and export/import functions for the analysis and forecast of international trade. These models have been prepared by various institutions and therefore differ in terms of the level of their detailed descriptions and finish.

Gravity equations have widely been used in empirical studies addressing the issues in international trade (O.Havrylyshyn et al. (1991), M.Sanso et al. (1993), etc.). Four categories of gravity equations applications are most well-known: estimating the cost of the border, explaining trade patterns, identifying the effects related to regionalism and the calculation of trade potentials. The calculation of trade potentials has in particular been used widely for Central and Eastern European Countries (Z.Wang et al. (1991), O.Havrylyshyn (1991), R.Baldwin (1993), D.Schumacher (1997)). E. Leamer (2000), A. Harisson et al. (1999), and M. Slaughter (1998) analysed the relationship between trade and employment.

The modelling of Lithuanian export could be carried out (for certain remuneration) by various organizations, e.g. World Bank, UNCTAD, WTO, etc. While modelling exports of various countries the above-mentioned institutions apply gravity and econometrical models. However, they cause some additional problems. For example, only the final results of export modelling, with certain explanatory notes, are provided in the closing section of the analysis. As a rule, the physical implications remain obscure and insufficient, which worsens the reliability of the results. With the aim of avoiding the aforementioned drawbacks, we recommend using the methods of export analysis and EDSS as were developed by the authors of the paper by offering the following practical solutions: analysis of the competitiveness of export sectors; analysis of the competitiveness of Lithuanian export products; analysis of the prospective markets.

The worldwide largest trade database COMTRADE (the United Nations Statistical Division) is used for carrying out the above-mentioned analyses. The Database collects information on 184 countries and 3,500 products, which covers approximately 90% of the world trade.

The physical implications of the recommended methods for export analysis and EDSS are in this way absolutely clear. This would provide a basis for carrying out a Lithuanian export analysis by using different profiles on a regular basis.

Multiple Criteria On-Line Export Decision Support System (EDSS) comprises of the following three constituent parts: data (database and its management system), models (model base and its management system) and a user interface.

According to the user's needs, various models of EDSS may be provided by a model management system. When a certain model (i.e. determination of criteria weights) is used, the results obtained become the initial data for some other models (i.e. a model for multiple criteria analysis and for the setting priorities).

EDSS stores and processes information and data from various sources. The developed EDSS enables consumers to transform unprocessed data into information necessary

for the analysis of a particular problem and to be used for further decision-making.

The following multiple criteria analysis methods and models as developed by the authors (1998) are used by the EDSS in the analysis of the competitiveness of export sectors, exported products and prospective markets:

A new method and model of complex determination of the weight of the criteria taking into account their quantitative and qualitative characteristics was developed. This method allows to calculate and coordinate the weights of the quantitative and qualitative criteria according to the above characteristics.

A new method and model of multiple criteria complex proportional evaluation of the projects enabling the user to obtain a reduced criterion determining complex (overall) efficiency of the project was suggested. This generalized criterion is directly proportional to the relative effect of the values and weights of the criteria considered on the efficiency of the project.

In order to find what price will make an object being valued competitive on the market a method and model of determining the utility degree and market value of projects based on the complex analysis of all their benefits and drawbacks was suggested. According to this method the objects utility degree and the market value of an project being estimated are directly proportional to the system of the criteria adequately describing them and the values and weights of these criteria.

A new method and model of multiple criteria multivariant design of a project life cycle enabling the user to make computer-aided design of up to 100,000 alternative project versions was developed. Any project life cycle variant obtained in this way is based on quantitative and conceptual information.

While analysing export, the main issue that should be solved in this regard, is the determination of the system of criteria, giving a detailed definition of the export.

The formation of systems of criteria describing sectors, products and markets was based on thoughts of different authors. This is because the goals of interested groups and systems of criteria describing sectors, products and markets by some means are relatively subjective. Therefore, in order to increase the level of objectivity of this analysis, the formation of systems of criteria describing sectors, products and markets was based on ideas of professionals and different literature from within the field.

Systems of criteria exhaustively reflect the sectors analyzed products and markets at this moment in time and the prospects of their development.

Analysis of the competitiveness of export sectors of a country under consideration is carried out in a complex way by using comparisons with other countries, at this moment in time and according to changes in performance.

On the basis of the COMTRADE database (of the United Nations Statistics Division), a database of international competitiveness analysis of export sectors of 7 countries (Denmark, Finland, France, Germany, Lithuania, Portugal, UK) was formed.

The results of the comparative analysis of export sectors are presented as a grouped decision making matrix where columns contain n export sectors of a country under consideration.

The diversity of aspects being assessed should include a variety of presented data needed for decision-making.

After a multiple criteria analysis of the export sectors, the following will be determined: priority of the sectors; tendencies.

The results of the multiple criteria analysis of the UK's export sectors carried out by the EDSS coincide with ITS calculations was based on COMTRADE.

In order to determine the most effective exported products of a country under consideration, their competitiveness analysis was carried out, both statically and dynamically.

The results of the comparative analysis of exported products are presented as a grouped decision making.

After completing a multiple criteria analysis of exported products of a country under consideration, the following will be determined: priority of products of a country under consideration; tendencies.

The results of the multiple criteria analysis of the Danish export products carried out by the EDSS coincide with ITS calculations was based on COMTRADE of UNSD. The 2nd alternative (Petroleum oils and oils obtained from bituminous minerals, crude; utility degree  $N_2=23.44$ ) is better than the 1st alternative (Meat from swine that was fresh, chilled or frozen;  $N_1=22.04$ ), i.e. export of the 2nd alternative (Petroleum oils and oils obtained from bituminous minerals, crude) is 1.06 ( $N_2 : N_1 = 23.44 : 22.04 = 1.6$ ) times more efficient than the export of the 1st alternative (Meat from swine that was fresh, chilled or frozen).

On the basis of the COMTRADE database, a database of market analysis of exact exported Lithuanian product was formed.

During a market analysis of each of the exact exported Lithuanian product, such a database has to be filled in.

After a multiple criteria analysis of the sectors, the following will be determined: priority of the market for each product; tendencies.

Having exhaustive conceptual and quantitative information, as well as the results of multiple criteria analysis of sectors, products and markets, as stated above, it is then possible to take them into consideration and more effectively carry out negotiations with the prospective importers.

## Conclusions

Different export on-line systems have been used in recent years to solve a wide variety of export problems. The purpose of this paper is to examine the current status of on-line export systems and indicate how multiple criteria on-line decision support systems can overcome some of the limitations of existing systems. Current on-line export systems is lacking of multiple criteria analysis

possibilities. In this paper we consider a Multiple Criteria On-Line Export Decision Support System (EDSS) as was developed by the authors (<http://193.219.145.94/>) and show how this system can be used for solving different export problems. In the paper a short description of the EDSS in the analysis of sectors, products and markets is provided. EDSS was developed to help exporters make decisions when faced with rapidly changing export conditions and to strengthen their problem-solving abilities. The EDSS, designed for export analysis, includes three basic units: data (database and its management system), models (model base and its management system) and a user interface.

## References

- [1] BizownerHQ.com. [www.bizownerhq.com/](http://www.bizownerhq.com/) [accessed on September 28, 2001].
- [2] Open Harbor. <http://www.mycustoms.com> [accessed on October 27, 2001].
- [3] TRADEPAQ Corporation. <http://www.tradepaq.com/> [accessed on October 25, 2001].
- [4] ValiCert Inc. <http://www.tradenable.com/> [accessed on November 14, 2001].
- [5] Expeditors International of Washington Inc. <http://snap.expd.com/> [accessed on October 25, 2001].
- [6] Metal Origins L.L.C. <http://www.metalorigins.com/> [accessed on November 12, 2001].
- [7] World Federation of Trading House Associations. Complete export pricing calculator. <http://www.wfta.org/calculator/Calculator2.htm> [accessed on November 12, 2001].
- [8] Bank one corporation. Import calculator. <http://www.bankone.com/international/tools/importer/eu/> [accessed on September 12, 2001].
- [9] Export Development Canada. Exposure Fee Calculator. <http://www.edc-see.ca/expfee/ExposureFee.ASP?Language=e> [accessed on October 29, 2001].
- [10] Foreign Trade On-Line. Interest/Loan Payment Calculator. <http://www.foreign-trade.com/resources/interest.cfm> [accessed on November 5, 2001].
- [11] JoC global transport analyser. The Journal of commerce. <http://www.joc.com/gta/> [accessed on November 14, 2001].
- [12] Business technology network. Expert system acts as outside business consultant <http://www.informationweek.com/760/expert.htm> [accessed on September 5, 2001].
- [13] Nusbaum R.C. The state of art decision support system <http://www.garmentsoft.com/> [accessed on October 15, 2001].

# A Detailed Procedure for Using Copulas to Classify E-Business Data

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## Abstract

Decision support systems are widely implemented to effectively utilize the tremendous amount of data generated by information systems throughout an organization. In one common implementation, the goal is to correctly classify a customer so that appropriate action can take place. This may take the form of a customized purchase incentive given to increase the probability that a transaction is completed, while enhancing profitability. Intelligent agents employing neural network technology that function as Bayesian classifiers are one approach used here.

Another approach that has been around for decades, called copulas, to our knowledge has yet to be utilized for classification in e-business applications. Copulas are functions that can describe the dependence among random variables. The very fact that copulas directly address codependence among variables may make them especially attractive in e-business applications where large numbers of correlated attributes may be present that could negatively affect the performance of other methods. In this paper, the basics of Bayesian decision making and posterior probabilities are reviewed. A detailed procedure for using copulas as Bayesian classifiers for e-business data is presented. The emphasis in describing the method is placed upon practitioner understanding to facilitate replication in real situations while maintaining technical rigor to ease computerized implementation.

## 1. Introduction

The impact of technology is being felt throughout the organization. Information technology is redefining not only how organizations develop strategies but the concepts of organizational learning and the nature of the organizational forms that are possible (e.g., [5] [14] [19]). At the tactical and operational levels, processes throughout the organization are rapidly being reengineered to incorporate the e-business approach.

All these information systems generate a tremendous amount of data for use in organizational decision processes. Effectively utilizing these data repositories is a key to not only meeting articulated business needs but to maximizing an organization's return on investment as well. For example, consider a common e-commerce application. Web-based retailers often track customer search and browsing records in addition to purchase information. This data can then be linked with internal databases, with external affiliate sources, and with readily available

demographic data to provide sophisticated customer profiles. As a result, individualized purchase incentives, suggested add-on purchase items, customized advertising schemes and email distributions can quickly be created to increase sales, enhance profitability, and develop customer loyalty (e.g., [5] [11] [18] [20]).

The goal in situations like the aforementioned is to accurately classify the customer (object) in question so that appropriate action can take place. Many technologies have been utilized to effect classifications in e-business applications. Some, such as data mining, intelligent agents, and neural computing are relatively new. Others, such as logistic regression, have been widely used for decades. Many times these methods are used in concert. For example, an intelligent agent may be employed to customize a follow-up email for a new customer. As attribute data is collected on the new customer, a neural computing model is used to estimate the probability of the customer making subsequent purchases. The intelligent agent, in turn, enters an appropriate enticement into the email.

Often, the approach employed by the classification method tries to estimate the probabilities, called posterior probabilities, associated with an object belonging to each of the possible groups based upon observed attributes. The classifier, in its simplest form, assigns the object as belonging to the group to which it has the highest probability of belonging. This is known as Bayesian classification and is often employed with neural networks and logistic regression applications.

Another approach that has been around for decades, called copulas, to our knowledge has yet to be utilized for classification in e-business applications. Copulas are functions that can describe the dependence among random variables and have been used in applications such as risk analysis [7], the analysis of accident precursor events [23], and for aggregating expert opinions [10]. In each of these situations, correlated events and variables are likely. As will be seen, copulas can be used to develop the likelihood functions that are integral to estimating the posterior probabilities used in Bayesian classification and seem promising for e-business applications. The very fact that copulas directly address codependence among variables may make them especially attractive in this realm where large numbers of correlated attributes may be present that could negatively affect the performance of regression models and neural networks.

The remainder of this paper is structured as follows. The next section reviews the basics of posterior

probabilities and Bayesian decision making. Then, three models that can function as Bayesian classifiers in e-business applications: logistic regression, neural networks, and copulas are discussed. The goal here is to illustrate how each model approaches the Bayesian classification problem in a distinctly different manner. Particular attention is paid to copulas as they are not as widely used as the other two in e-business applications. Next, a step-by-step process for building and using a copula-based approach in an e-business environment is detailed. The final section concludes the paper and discusses further considerations for interested readers.

## 2. Posterior Probability and Bayes

In a classification problem setting, the underlying population generating process characterizes the relationship between the input attributes and the output classes. This relationship defines what is called the posterior probability distribution. At this point, simply note that the posterior probability is a quantity giving the probability that an object belongs to a specified class after we have observed information related to the classification decision.

For example, consider a situation in which perhaps 50 percent of customers who begin the checkout process at a website actually complete the transaction. Without any information concerning a customer, the best we could say is that there is a 50 percent (prior) probability that the next customer will actually complete the transaction. However, after obtaining information on the customer, such as site visit history or previous purchases made, for example, we could modify our probability of transaction completion either up or down from 50 percent to reflect this newly obtained information. Appropriate action could then be taken to maximize expected sales and profits from the customer and transaction.

Posterior probability forms the basis of the well-known Bayesian classification theory [8]. An object's posterior probability is a quantity of great interest, since it allows us to make optimal decisions regarding the class membership of new data. Consider a case with  $J$  groups ( $w_j$ ) that are described by  $N$  variables ( $x_n$ ) where  $P(w_j)$  is the prior probability that a randomly selected object belongs to group  $j$ . According to Bayes rule, if we obtain information contained in an observation  $(x_1, \mathbf{K}, x_n)$ , the prior probability will be revised into the posterior probability,  $P(w_j | x_1, \mathbf{K}, x_n)$ , that the given object  $(x_1, \mathbf{K}, x_n)$  belongs to group  $j$ . That is,

$$P(w_j | x_1, x_2, \mathbf{K}, x_n) = \frac{f(x_1, x_2, \mathbf{K}, x_n | w_j) \cdot P(w_j)}{\sum_j f(x_1, x_2, \mathbf{K}, x_n | w_j) \cdot P(w_j)} \quad (1)$$

where  $f(x_1, x_2, \mathbf{K}, x_n | w_j)$  is the conditional likelihood function for each group,  $w_j$ , and the denominator represents the unconditional joint

distribution  $f(x_1, x_2, \mathbf{K}, x_n)$ . Bayes rule shows how observing the value of  $(x_1, \mathbf{K}, x_n)$ , the attributes for the object, changes the prior probability  $P(w_j)$  to the posterior probability  $P(w_j | x_1, \mathbf{K}, x_n)$  upon which the classification decision is based.

Furthermore, suppose that a particular  $(x_1, \mathbf{K}, x_n)$  is observed and is to be assigned to a group. Let  $\lambda_{ij}(x_1, \mathbf{K}, x_n)$  be the cost of misclassifying  $(x_1, \mathbf{K}, x_n)$  to group  $i$  when it actually belongs to group  $j$ . Since  $P(w_j | x_1, \mathbf{K}, x_n)$  is the probability that the object belongs to group  $j$  given attributes  $(x_1, \mathbf{K}, x_n)$ , the expected loss associated with assigning  $(x_1, \mathbf{K}, x_n)$  to group  $i$  can be minimized by following the Bayesian decision rule for classification,

Decide  $w_k$  for  $(x_1, \mathbf{K}, x_n)$  if  $L_k(x_1, \mathbf{K}, x_n)$

$$= \min_{i=1,2,\mathbf{K},M} \sum_{j=1}^M \lambda_{ij}(x_1, \mathbf{K}, x_n) P(w_j | x_1, \mathbf{K}, x_n) \quad (2)$$

A loss function of particular interest in the literature is known as the symmetrical or zero-one loss function. The zero-one loss function is specified as  $\lambda_{ij}(x_1, \mathbf{K}, x_n) = 1$  for  $i \neq j$ , and 0 otherwise. This binary loss function assigns a zero cost to a correct decision while assigning a unit loss to all misclassifications. In this case, the Bayesian decision rule is to assign an object to the group associated with the maximum posterior probability:

Decide  $w_k$  for  $(x_1, \mathbf{K}, x_n)$  if  $P(w_k | x_1, \mathbf{K}, x_n)$

$$= \max_{j=1,2,\mathbf{K},M} P(w_j | x_1, \mathbf{K}, x_n) \quad (3)$$

This decision rule yields a minimum expected misclassification rate or, in other words, the maximum overall number of correct classifications in the long run.

## 3. Models for Estimating Posterior Probabilities

The above discussion clearly shows the important role of posterior probabilities in the Bayesian classification decision. It is readily apparent from Bayes rule, that accurately estimating the likelihood functions is a key to obtaining reliable posterior probability estimates for objects. Logistic regression, neural networks, and copula-based methods can all be used as Bayesian classifiers as discussed next.

### 3.1 Logistic Regression

Logistic regression attempts to estimate posterior probabilities and likelihood functions based on the Bernoulli distribution by utilizing a logistic response function of the general form

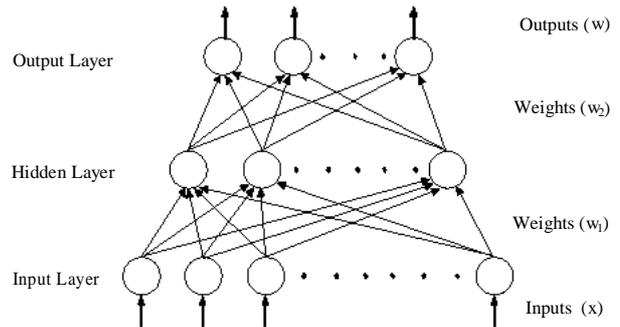
$$E(w) = \frac{\exp(\beta_0 + \beta_1 X_1 + L + \beta_n X_n)}{1 + \exp(\beta_0 + \beta_1 X_1 + L + \beta_n X_n)}. \quad (4)$$

where  $E(w | x_1, K, x_n) = P(w | x_1, K, x_n)$ . The maximum likelihood estimates for the  $\beta$ 's are determined via iterative numerical search procedures. Logistic regression is readily available in statistical packages such as SAS or SPSS and quickly yields a model for given data with minimal computational delay. Logistic regression is well understood by practitioners and has enjoyed success in a wide range of classification problem settings. Neter, Kutner, Nachtsheim, & Wasserman [17] contains an excellent discussion of logistic regression for interested readers.

Logistic regression does have limitations worth noting. Perhaps the most significant one is the a priori specification of the logistic response function, which may restrict the utility of the regression to model in the presence of complex relationships. For example, correlated inputs are known to impact model performance. Also, performance degradation may be seen in situations where the input attributes variance-covariance matrix is not constant between groups. As a practical matter, often a variable selection process is used to overcome such problems but adds another dimension of complexity to this fixed-form approach.

### 3.2 Neural Networks

Neural networks take a fundamentally different approach to estimating posterior probabilities for classification. A neural network is a parallel system of interconnected computing elements called nodes. Information is processed via the interaction between nodes where knowledge is represented by the weights of the connections between them. Figure 1 shows a simple three-layer feedforward network representative of those used in this research. The first or lowest layer is called the input layer where external information enters the network while the last or top layer is called the output layer where the network produces the model solution. The middle layer or hidden layer provides the connections necessary for neural networks to identify complex patterns in the data. All nodes in adjacent layers are connected by acyclic arcs from the input layer to the hidden layer and from the hidden layer to the output layer [2].



**Figure 1. Multi-layer feedforward neural network.**

An optimization process is utilized to minimize the difference between the targets—typically zero and one, representing the true groups to which the objects belong—and the neural network estimates of group membership. The theoretical relationship linking estimation of Bayesian posterior probabilities to neural networks has long been known (e.g., [1] [4] [9]). For an excellent discussion of designing and using neural networks for estimating posterior probabilities, interested readers are directed to [3].

Often neural networks are said to be parameter-free or data-dependent models. This means that the form of the neural network employed is not prespecified as in logistic regression. Rather, through experimentation with various numbers of hidden nodes, in conjunction with weight matrix determination via nonlinear optimization, the data itself determines the model form to be used. In this way, neural networks directly estimate the posterior probabilities associated with the observed objects and the likelihood functions they represent. This allows neural networks to model complex relationships in a wide array of problem settings and is a primary reason for their recent usage and success.

While neural networks are theoretically flexible they are not without practical limitation. The hidden node determination is not trivial, requiring multiple training and testing activities. In addition, the neural network optimization is sensitive to the initial weight values. This necessitates using multiple random initializations and optimizations at each hidden node to increase the probability of finding an acceptable solution. These factors combine to make model building quite time consuming and calculation intensive, even for less complex problems. Because the data are so integral to determining appropriate model form, with neural networks it is especially important to segregate some of the data to make selecting the best number of hidden nodes independent of neural network training.

### 3.3 Copulas

A copula approach to classification is fundamentally different from these other methods, and as such, holds potential as an alternative when other methods do not perform well or in combination with them. In general, the copula approach described in this paper attempts to

decompose the joint cumulative distribution function represented by the data set into two components. First, the joint distribution is split into independent marginal cumulative distribution functions. Next, a second function, called a copula, is developed that specifies the interrelationship between the random variables. Then, these components are used to estimate the posterior probabilities associated with the objects in the data set. This copula approach to classification relies upon Sklar's Theorem, which is expressed as

Sklar's Theorem [22]. Given a joint cumulative distribution function  $F(x_1, \mathbf{K}, x_n)$  for random variables  $X_1, \mathbf{K}, X_n$  with marginal cumulative distribution functions (CDFs)  $F_1(x_1), \mathbf{K}, F_n(x_n)$ ,  $F$  can be written as a function of its marginals:

$$F(x_1, \mathbf{K}, x_n) = C[F_1(x_1), \mathbf{K}, F_n(x_n)],$$

where  $C(u_1, \mathbf{K}, u_n)$  is a joint distribution with uniform marginals. Moreover, if each  $F_i$  is continuous, then  $C$  is unique, and if  $F_i$  is discrete, then  $C$  is unique on  $\text{Ran}(F_1) \times \mathbf{L} \times \text{Ran}(F_n)$ , where  $\text{Ran}(F_i)$  is the range of  $F_i$ .

The function  $C$  is called a copula and describes the interrelationship between the random variables. Sklar's Theorem is especially useful because any joint distribution can be written in copula form without limitation.

To facilitate presentation and to ease understanding, consider the case where each  $F_i$  is continuous and differentiable, where the joint density  $f(x_1, \mathbf{K}, x_n)$  is written as

$$f(x_1, \mathbf{K}, x_n) = f_1(x_1) \times \mathbf{L} \times f_n(x_n) \cdot c[F_1(x_1), \mathbf{K}, F_n(x_n)]. \quad (5)$$

$f_i(x_i)$  is the density that corresponds to  $F_i(x_i)$  and  $c = \partial^2 C / (\partial F_1 \partial F_n)$  and is known as the copula density. This shows that the joint density can be represented as a function of the marginal densities and the copula density [7]. For independent random variables,  $c = 1$  indicates no dependence among the variables as the above equation simplifies to  $f(x_1, \mathbf{K}, x_n) = f_1(x_1) \times \mathbf{L} \times f_n(x_n)$ . When dependence among variables is present,  $c \neq 1$  thereby encoding the interrelationship between variables. If a group  $w_j$  is specified, then  $f(x_1, \mathbf{K}, x_n)$  becomes  $f(x_1, \mathbf{K}, x_n | w_j)$  and the relationship to posterior probabilities via Bayes rule is clear.

Equation (5), therefore, provides a clear path on how to use the copula approach for estimating posterior probabilities in (1) for use in Bayesian classification per equations (2) and (3).

The copula density concept is likely to be unfamiliar to

most readers, though, and deserves further discussion. The focus in this paper is on the multivariate normal copula family. It is called multivariate normal because it uses pairwise correlations between variables to represent dependence among variables in the same manner that the multivariate normal distribution is parameterized in terms of Pearson product-moment correlations [7]. By using a nonparametric correlation measure, such as the Spearman's  $\rho$  or Kendall's  $\tau$ , however, multivariate normal copulas are flexible in that they can allow any marginal distribution for the input attributes. Steps 3 – 8 in the procedure below, detail precisely how this is accomplished.

As a result, the copula approach provides a flexible and useful approach to describing complex relationships among variables that can be used in conjunction with Bayes rule to develop Bayesian classifiers. Copulas have been underutilized given recent advances in the ease of data acquisition, the great speed of computational capabilities, and the availability of commercial packages enabling probability distribution fitting and estimation. Therefore, a primary goal of this paper is to detail a procedure for using a copula-based approach in decision making processes.

The copula approach to classification represents an exciting addition to the tool chest of techniques available for e-business applications. The novelty of its approach clearly distinguishes it from the other two. Copulas are by no means a panacea or guaranteed to perform better than the other methods. Copulas require estimates of marginal distributions and correlations between variables. This makes them more computationally intensive than logistic regression but less so than neural networks. In addition, many copula families exist and must be user specified. The multivariate normal copula family is particularly flexible and is used in the example problem as detailed in the procedure described next.

#### 4. Procedure for Using Copulas with E-Business Data

In this section, a general procedure for developing and using multivariate copulas for classifying objects is presented. The goal is to clarify how copulas can be implemented with e-business data to improve decision making. The focus is on facilitating practitioner understanding with an acknowledged tradeoff in brevity and computational efficiency. Readers interested in detailed theoretical development and proofs relating to copulas are directed to [7] [10] [16] [21].

There are four phases to using copulas in e-business applications. Phase one consists of collecting and processing the raw data. Phase two focuses on building the copula model. Phase three describes how to use the copula model to estimate posterior probabilities. Phase four, meanwhile, discusses using the copula model with newly acquired data.

#### 4.1 Phase One—Collecting and Processing Data

STEP 1: Collect data on objects (e.g., customers) of interest from system.

STEP 2: Segment the objects into  $j$  groups ( $w_j$ ) as appropriate for decision making.

#### 4.2 Phase Two—Building a Copula Model to Couple the Marginal Distributions

STEP 3: Calculate correlation matrix ( $R_j$ ) for the independent variables  $X_1, K, X_n$  for each group  $w_j$ . While the multivariate normal copula is parameterized in terms of the Pearson product-moment correlations, to avoid the limitation of normally distributed independent variables, use nonparametric approaches such as Spearman's  $\rho$  or Kendall's  $\tau$  thereby creating  $R_j^*$ . Next, convert  $R_j^*$  into  $R_j$  via a simple transformation. For Spearman's, the conversion for each element  $r_{ij}$  is  $r_{ij} = 2 \sin(\pi \rho_{ij}/6)$ . For Kendall's, the conversion is  $r_{ij} = \sin(\pi \tau_{ij}/2)$ . For example, in a two-group case with three input variables, two, 3x3 correlation matrices will be generated.

STEP 4: For each  $R_j$  calculate the inverse ( $R_j^{-1}$ ) and the square root of the determinant ( $\sqrt{|R_j|}$ ). These will be used for copula calculations in STEP 8.

STEP 5: Fit marginal distributions to each independent variable  $X_i$  for each group  $w_j$ . Save the distribution information for use in subsequent steps (e.g., Normal( $\mu, \sigma$ )). This can be accomplished using packages such as MatLab, SPSS, SAS, or using a distribution fitting program such as ExpertFit [12]. Law and Kelton [13], Morgan and Henrion [15], and Clemen [6] provide more information on this issue for interested readers. For a two-group three-input case, each of the three variables will be fitted twice.

STEP 6: For each object (realization) ( $x_1^k, K, x_n^k$ ), compute the cumulative density functions (CDFs) and probability density functions (PDFs) associated with each of the marginal distributions found in STEP 5. Call the CDFs ( $F_{11}^k, F_{12}^k, L, F_{1n}^k$ ) ... ( $F_{j1}^k, F_{j2}^k, L, F_{jn}^k$ ) for each of the  $j$  groups and  $n$  variables. Call the PDFs ( $f_{11}^k, f_{12}^k, L, f_{1n}^k$ ) ... ( $f_{j1}^k, f_{j2}^k, L, f_{jn}^k$ ). Therefore, for a two-group case, each object will have two CDFs and two PDFs estimated for each variable.

STEP 7: For each of the  $k$  objects, compute the inverse univariate standard normal from the  $n$  CDFs found in STEP 6 as  $y_{jn}^k = \Phi^{-1}(F_{jn}^k)$  where  $\Phi \sim \text{Normal}(0,1)$ . Let  $y_j^k$  be the column vector  $y_j^k = [y_{j1}^k, y_{j2}^k, K, y_{jn}^k]$  of object  $k$  for group  $w_j$ . For a two-group case, each object will have two estimates,  $y_1^k$

and  $y_2^k$ .

STEP 8: Calculate the point estimate of the copula density of each object  $k$  for every group  $w_j$ . The copula density is found as

$$C_j^k = e^{-\frac{1}{2} (y_j^k)^t R_j^{-1} y_j^k} / \sqrt{|R_j|}$$

where  $y_j^{k,t}$  is the transpose of  $y_j^k$ .

#### 4.3 Phase Three—Using the Copula Model to Estimate Posterior Probabilities

STEP 9: For each object (realization) ( $x_1^k, K, x_n^k$ ), compute the likelihood function for every group  $w_j$ . The likelihood function is calculated as

$$f^k(x_1, x_2, K, x_n | w_j) = f_{j1}^k(x_1) \times f_{j2}^k(x_2) \times L \times f_{jn}^k(x_n) \times C_j^k.$$

STEP 10: Compute the unconditional joint distribution for each object. This is found as

$$f^k(x_1, x_2, K, x_n) = \sum_{j=1}^j f^k(x_1, x_2, K, x_n | w_j) \cdot P(w_j)$$

where  $P(w_j)$  is the prior proportion of group  $w_j$  objects in the data.

STEP 11: Compute the posterior probabilities of each object belonging to each group. The posterior probabilities are calculated as

$$P^k(w_j | x_1, x_2, K, x_n) = \frac{f^k(x_1, x_2, K, x_n | w_j) \cdot P(w_j)}{f^k(x_1, x_2, K, x_n)}$$

These probability estimates are then used in Bayesian decision making for classification as shown in equations (2) and (3). When an equal cost of misclassification assumption is used, the objects are assigned to the group corresponding to the highest posterior probability. Make appropriate decisions for each classification, such as offer a purchase enticement to objects classified as group  $w_2$ , a customer unlikely to purchase again.

The copula model has just been finalized and utilized to calculate posterior probabilities associate with the known objects. Next, we turn to the issue of how to use a copula model for classifying future observations.

#### 4.4 Phase Four—Using Copula Model with New Data

STEP 12: Collect additional data on objects (e.g., customers) of interest from the system to be used to make immediate classification decisions and to take appropriate actions.

STEP 13: Repeat STEPS 6 – 11 for each newly obtained object. Use information calculated previously from STEPS 3–5, but do not recalculate these steps. Make appropriate decisions in STEP 11 based upon the group to which the object is assigned.

### 5. Conclusion

Information systems are generating a tremendous amount of data for use in e-business decision processes. Effectively utilizing these data repositories to make

decisions consistent with the organizations tactical and strategic objectives can be a key to achieving and sustaining competitive advantage. E-business decision support systems have frequently employed data mining, neural computing, intelligent agents, and regression approaches, alone or in concert to turn these data into information and knowledge.

Copulas are another approach that is promising for e-business applications. Like neural networks or logistic regression, copulas can be used to accomplish Bayesian decision making as part of a decision support system. Fundamentally, though, the copula approach to analyzing the data is quite different from these other methods. In particular, a copula approach directly addresses the codependence among variables. This may be especially desirable in e-business applications where large numbers of correlated variables exist that may negatively impact the performance of other methods.

In this paper, the basics of Bayesian decision making and posterior probabilities are reviewed. Next, the neural networks, logistic regression, and copula approaches to estimating the posterior probabilities upon which Bayesian decision making is based in discussed. The focus is on understanding how each method works so that the differences can be understood. Finally, a detailed method for using copulas to classify e-business data is presented. The emphasis is placed upon practitioner understanding to facilitate replication in real situations while maintaining technical rigor to ease computerized implementation.

## 6. References

- [1] Baum, E.B., & Wilczek, F. Supervised learning of probability distributions by neural networks. In D. Anderson (Ed.) *Neural Information Processing Systems*, New York: American Institute of Physics, 1988, 52-61.
- [2] Berardi, V.L., & Zhang, G.P. The effect of misclassification costs on neural network classifiers. *Decision Sciences*, 1999, 30, 13, 659 – 682.
- [3] Bishop, C.M. *Neural Networks for Pattern Recognition*, Oxford, Clarendon Press, 1995.
- [4] Bourlard, H., & Wellekens, C.J. Links between Markov models and multilayer perceptrons. In D.S. Toretzky (Ed.) *Advances in Neural Information Processing Systems*, San Mateo, CA: Morgan Kaufmann, 1989, 1, 502-510.
- [5] Bult, J.R., & Wansbeek, T. Optimal selection for direct mail. *Marketing Science*, 1995, 14, 4, 378-394.
- [6] Clemen, R.T. *Making Hard Decisions: An Introduction to Decision Analysis*, 2<sup>nd</sup> ed., Duxbury, Belmont, CA, 1996.
- [7] Clemen, R.T. & Reilly, T. Correlations and copulas for decision and risk analysis. *Management Science*, 1999, 45, 2, 208-224.
- [8] Duda, R.O., & Hart P. *Pattern Classification and Scene Analysis*. New York: Wiley, 1973.
- [9] Hung, M.S., Hu, M.Y., Patuwo, B.E., & Shanker, M. Estimating posterior probabilities in classification problems with neural networks. *International Journal of Computational Intelligence and Organizations*, 1996, 1, 49-60.
- [10] Jouini, M., & Clemen, R.T. Copula models for aggregating expert opinions. *Operations Research*, 1996, 44, 3, 444-457.
- [11] Karauga, G.G., Khraban, A.M., Nair, S.K., & Rice, D.O. AdPalette: an algorithm for customizing online advertisements on the fly. *Decision Support Systems*, 2001, 32, 85-106.
- [12] Law, A.M. ExpertFit, Averill M. Law & Associates, [www.averill-law.com](http://www.averill-law.com), 2002.
- [13] Law, A.M. and W.D. Kelton. *Simulation Modeling and Analysis*, 2<sup>nd</sup> Edition. McGraw-Hill, 1991.
- [14] Li, Shuliang. The Development of a Hybrid Intelligent System for Developing Market Strategy, *Decision Support Systems*, 2000, vol.27, pp.395-409.
- [15] Morgan, G.M., & Henrion, M. *Uncertainty*. Cambridge University Press, Cambridge, 1990.
- [16] Nelson, R.B. Copulas, characterization, correlation, and counterexamples, *Mathematics Magazine*, 1995, 68, 193-198.
- [17] Neter, J., Kutner, M.H., Nachtsheim, C.J., & Wasserman, W. *Applied Linear Statistical Models*, 4<sup>th</sup> Edition, McGraw-Hill, 1996.
- [18] Palmer, Ann T. Online Savings Are In Bloom, *Business Week*, July 22, 2002. pg. 10.
- [19] Raymond, L., & Blili, S. Organizational learning as a foundation of electronic commerce in the network organization. *International Journal of Electronic Commerce*, 2001, 5, 2, 29-45.
- [20] Schmittlein, D.C., & Peterson, R.A.. Customer base analysis: an industrial purchase process application. *Marketing Science*, 1994, 13, 1, 41-67.
- [21] Schweizer, B. Thirty years of copulas. G. Dall'Aglio, S. Kotz, G. Salinetti, eds. *Advances in Probability Distributions with Given Marginals*, Kluwer, Dordrecht, Netherlands. 1991, 13-50.
- [22] Skylar, A. Fonctions de repartition a n dimensions et leurs marges. *Publications de l'Institut Statistique de l'Universite de Paris*, 1959, 8, 229-231.
- [23] Yi, W., & V. m. Bier. An application of copulas to accident precursor analysis. *Management Science*, 44, S257-S270, 1998.

# Measuring IT Contribution to Company's Competitive Advantages

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## Abstract

The objectives of this research are to detail the history of business-IT alignment and develop a model to measure business-IT strategic alignment. The methodology involved defining and developing measures for the predictor variables of environmental uncertainty and importance of IT to the firm. A conceptual framework or strategic alignment model integrating key practices espoused by academics and practitioners regarding strategic alignment was developed. Measures for the strategic alignment model were defined and developed, and the relationships of the predictor variables with the degree of alignment as well as technology's contribution to organizational performance assessed.

## 1. Introduction

Business strategy and IT alignments and their contributions to business competitive advantages or performance have been much researched the early 1990s. Though most companies know that alignment is needed to facilitate optimum business benefit, it is difficult for them to know whether they have the strategy and technology aligned.

The literature review indicates that, to date, there does not appear to be a 'one-size-fits-all' solution to achieving agreement, coordination, and close cooperation between business strategy and IT strategy. Hence, this paper explores the history of business strategy-technology alignment (strategic alignment in short) and outlines the study being conducted by the authors to increase our knowledge of what the influences are upon business strategy-technology alignment and what impact such alignment has upon the organization. It reports only the preliminary findings as the research is still ongoing as this paper was written.

The overarching research objectives were set as

s define and develop measures for the predictor variables environmental uncertainty and importance of IT to the firm;

s develop a consolidated conceptual framework or

model based on the key practices espoused by academics and practitioners that influence strategic alignment;

s define and develop measures for the strategic alignment model; and

s assess the relationship of the predictor variables with the degree of alignment and the degree of alignment with technology contribution to organizational performance.

Specific benefits of the research were seen as the following:

s This study's contribution to practice will result primarily from identifying key practices with organizational outcomes given the influence of the contingency variables. Identification and measurement of the relationships between the variables and the linkages in the consolidated strategy alignment model should have important consequences for practitioners seeking ways to improve their contribution.

s Contributions to research will derive from the completeness of the model, use of the model's IT's importance to the firm as a contingency variable, and the use of the Key IT practices construct to provide relationships heretofore unexplored. It is expected that the degree of IT and Business Strategy alignment and the impact of key IT practices upon organizational performance will be moderated by the importance of IT to the firm.

s The strength of these relationships should provide directions for future research. For example, studies could be undertaken on why is there a strong relationship between customer service level and the alignment of IT and business. Future research would also benefit from examining the feedback effect of outcomes on the importance of IT to the firm as proposed in the research model.

## 2. Literature review and conceptual framework

### 2.1 History of the strategic alignment model

Alignment of the information systems plan with a company's business plan has been the subject of much research and has been cited as one of the chief problems facing business and IT planners and managers [4][6][14]; The first attempt could be traced back to 1991, when the results of the MIT research program *Management in the 1990s* were published [12]. Among them, a rudimentary framework emerged whereby information technology (IT) was regarded as a variable linked with other variables such as strategy, organization and culture.

The strategic alignment model that was first proposed and which became a body of thought for leading researchers until today was postulated by Henderson and Venkatraman in 1993. In that year, a special issue of the IBM Systems Journal featured a series of articles on the concept of 'strategic alignment', including the leading article by Henderson and Venkatraman [5]. These authors developed the idea stemming from their research within the *Management in the 1990s* project, conducted under a grant by the IBM Consulting Group. The model that they created gained widespread following in the profession.

The *Henderson and Venkatraman* model expresses the interrelationship between business and IT. It is based on two distinct linkages: strategic fit and functional integration. Strategic fit is the linkage concerned with the integration of the external environment in which the firm competes (e.g., business partners, clients and customers, government agencies, regulatory bodies, financial or lending institutions, key suppliers) and the internal environment in which the firm performs (e.g., process technology, organizational structure, human resources, innovative processes). Functional integration is the corresponding link between business and IT. This linkage extends the notion of internal and external fit to IT. These two linkages are used to determine the relationships between IT and business. The model is divided into quadrants, comprising business strategy, IT strategy, organizational infrastructure and processes, and IT infrastructure and processes. These quadrants are interrelated; how they relate represents the organization's 'perspective' or alignment orientation. Effecting a change in any single domain requires the use of three out of the four domains to assure that both strategic fit and functional integration are properly addressed.

Between 1995 and 1997, many studies were conducted based on the Henderson and Venkatraman strategic alignment model. The model was developed further and enhanced by some major researchers such as Papp, Brier and Luftman [7][8]. In 1995, the latter identified a total of

twelve perspectives. These included eight individual perspectives of strategy execution, technology potential, competitive potential, service level, organizational IT infrastructure, IT infrastructure strategy, IT organization infrastructure, and organization infrastructure strategy. In addition, four fusion perspectives were identified, namely, 'organization strategy fusion, IT strategy fusion, organization infrastructure fusion, IT infrastructure fusion' [7][8].

### 2.2 Maes'generic framework

Maes [9] felt that the Henderson and Venkatraman strategic alignment model was not perfect and proposed a modified strategic alignment framework, called the generic framework [9] in an attempt to counter the weaknesses in Henderson and Venkatraman model. Maes argued that the Henderson and Venkatraman model was incomplete because it only dealt with choices regarding organizational and technological infrastructure and processes. Because of this, Maes extended the 'information/communication' and 'operations' layers in the Henderson and Venkatraman strategic alignment model to include the critical links among the various quadrants.

### 2.3 CAP Gemini's Framework of Alignment

In May 2000, a white paper was published jointly by University of Amsterdam and CAP Gemini Institute that included the implementation component of the model and renamed the Unified Framework of Alignment [10]. In this paper, Maes' generic framework was enhanced to include the implementation components; namely, contextual, conceptual, logical, physical and transformational. This framework was created as a design tool aimed at development of mutually aligned business and IT systems through a unified architecture. Whilst Maes' generic framework is a tool for information management, the unified framework of alignment was created as a design tool aimed at development of a mutually aligned business and IT system through a unified architecture. Maes and CAP Gemini argued that business and IT alignment is a combined management and design concern. Thus, the combination of these two frameworks creates a complimentary of results. For example, Maes' framework would be further enhanced when it includes the design components; namely, the contextual, conceptual, logical, physical and transformational phases.

While the researchers cited above have claimed that measurements are important to the usefulness of the model, no studies have been conducted to justify the claims. Bruce [3] claimed that successful alignment could be accomplished via coordination of strategic objectives with

a number of key components: resources, management processes, decision-making mechanisms, performance measures, rewards, and incentives. Measures of alignment will thus be different for firms of different sizes, in different growth phases, and in different industries.

Further, Bruce argued that, most likely, these measures would fall into the following categories - cost leadership, product leadership and outstanding customer service. Bruce's scorecards included the three categories above and were further broken down into following measures: price, quality, customers, markets, cost of operations, channels as well as goods and services. Almost simultaneously, the Balanced Scorecard organization came up with a performance measurement framework for IT and business outcomes [1] [2] which showed areas where IT could add value to existing activities of an organization, as shown in table 1 below.

**Table 1: The value of corporate IT initiatives**

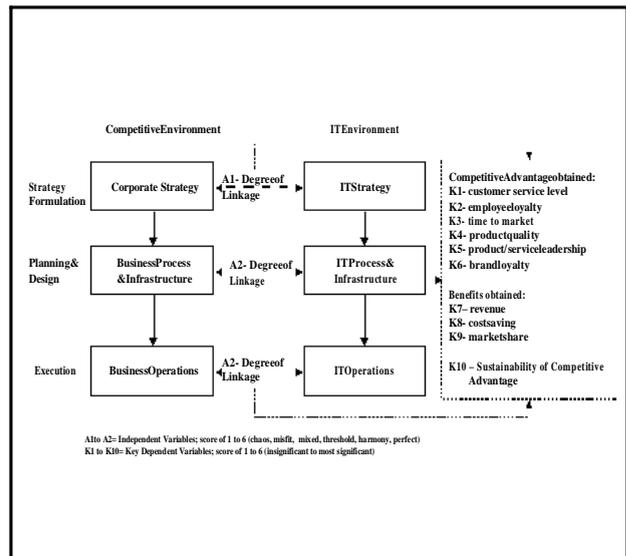
Representative systems	Competitive advantage - Value metrics
Electronic commerce (EDI, supplier management, electronic shopping, secure protocols)	Market share; Price premium for products/services
Information-based products and services (financial, market, and industry-specific information services)	Operating margins, New business revenues, cash flow, knowledge retention
Information value added to existing products and services (customer information networks, electronic catalogue)	Relative return on equity

Source: The Balanced Scorecard Institute

### 2.3 Development of alignment model

Because of the lack of measurements of strategic alignment, the managers today are not fully aware of the implication of strategic alignment. This is a window of opportunity for research in order to create management awareness and to address the competency gap. An attempt was made by the present authors to develop and 'measure' an eclectic strategic alignment model developed using various schools of thought; namely, Henderson & Venkatraman 1993, Maes' Generic Framework and CAP Gemini's Unified Framework of Alignment.

For ease of measurement, a modified 'consolidated' strategic alignment model or CSA model (refer to figure 1 below) was produced that merges the key concepts of the models discussed.



**Figure 1: The CSA model**

It closely resembles the McGeeand Prusak [11] model, with adaptations to include the links as proposed by Henderson and Venkatraman, Maes and CAP Gemini and common variables on competitive advantages and benefits.

*s Independent variables:* The primary independent variables were constructed to identify the strategic alignment at the corporate strategy, business process/infrastructure and operation/implementation level ('A' variables: The measures of tightness of linkage between IT and business strategies and operations. The higher the score, the more the firm demonstrates greater strategic sustainability).

*s Dependent variables:* Combining Bruce's [3] measures of strategic alignment with the metrics of the Balanced Scorecard Institute yielded key dependent variables for potential competitive advantage or benefits obtained. These include revenue, cost saving, customer service level, employee loyalty and job satisfaction, time to market, market share, product quality, market/product/service leadership and brand loyalty ('K' variables: The dependent variables that were generated as a result of degree of linkage in the A variables).

*s Moderator variables:* Moderator variables introduced comprised the computer systems used at different levels of strategy planning; i.e. corporate, business unit or operations.

*s Control variables:* Control variables used comprised manufacturing companies, namely companies with more than five years' profitable operation and companies with turnover of more than AUD 20 million per year.

### 3. Methodology

#### 3.1 Research approach

This research being an empirical study on the relationship between information technology, strategy planning and business processes design, the analytical survey method was adopted. Questionnaires were directed at senior information technology managers to obtain an organisational context and an understanding of the aims and critical success factors and their relationship to information technology strategy. In-depth questionnaire surveys were conducted for certain companies to provide contextual and broad understanding of business process and operation levels details.

The research methodology adopted for the pilot test was a field survey employing questionnaires. The latter were sent to senior IT executives and members of top management, within the same firm, in private corporations within Australia. This was hoped to facilitate statistical testing across a wide variety of organizations and reduce the effects of common source variance by measuring the independent and dependent variables from different respondents. Operationalisations of constructs was in the form of survey questions based on an extensive literature review and consideration of existing validated measures. Confirmatory factor analysis was used to measure the relationships among the variables.

#### 3.2 Data gathering

The sample of firms that participated in the study included manufacturing companies located in Australia. Several criteria were employed to determine the specific population from which the sample was drawn: (1) to ensure a minimal degree of homogeneity among the respondents, the firms included in the sample were restricted to manufacturing firms; (2) to reduce the confounding effects of diversification, the sample was limited to those firms that generate at least 70 per cent of their sales from a single industry [13].

Rather than relying on secondary data, and following practice common in many 'empirical' studies, questionnaires were used to collect data directly from senior information technology managers. Managerial opinion and perceptions were hoped to provide information that secondary data would not necessarily reveal. In the first stage of the survey instrument development, extant literature was perused to generate a pool of items and variables describing information technology-enabled strategic advantages. In addition to this, some industry expert advice was sought to assess the validity of the measures, the conceptual and functional equivalence of the constructs. The items or variables generated from the measurement development processes

were grouped, based on the literature review, into three categories:

s *Category 1*: Organisational arrangements: to understand organisational structure, policies, procedures, systems, and general corporate strategies.

s *Category 2*: Linkage between information technology and corporate strategy: to understand the strategic intent, the type of systems used, the degree of alignment and its associated benefits and any competitive advantages obtained at this level.

s *Category 3*: Linkage between information technology and business processes/operations: to understand the strategic intent, the type of systems used, the degree of alignment and its associated benefits and any competitive advantages obtained at this level.

The degree of linkage was measured on a 6-point Likert scale, ranging from 'chaotic' to 'perfect'. The degree of competitive advantage and benefits obtained due to the strength of the A1 and A2 variables was measured also on a 6-point Likert scale, ranging from 'insignificant' to 'most significant'.

The pre-test was conducted with IT personnel working in selected manufacturing companies, producing the pilot questionnaire. Two main groups of questions were asked. The first group of questions was posed to identify variables A1 and A2, and the executives were asked how strong the current alignment was in their companies between business strategies and IT strategies, and between business processes/operations and IT processes/operations. The second group of questions focused on aspects such as the current performance on variables K1 to K10. The main aim of this second group of questions was to obtain ratings on qualitative variables such as customer services and sustainability of competitiveness.

In the second stage, the questionnaire was test-run to ensure that the format was clear and logical and that the questions could be answered within half an hour. The refined questionnaire led to the actual implementation of data collection procedures.

To establish the significance of all the variables defined in the model and their effects on each other, data was collected by conducting in-depth interviews and by field surveys employing questionnaires sent to senior IT executives and members of top management within the selected firms. Quantitative data such as market share and revenue was obtained from the participating companies' financial statements and industry reports. As indicated above, information from various well-represented parties was obtained so as to facilitate statistical testing across a

wide variety of sources and to reduce the effects of common source variance by measuring the independent and dependent variables from different and informed respondents.

### 3.3 Data analysis

At the time of this analysis, of 200 survey questionnaires sent out, 37 responses had been received, yielding a response rate of 18.5%. The average number of years an IT manager had been in that position is 3.25 and for the CEO, it is 6.56. Based on simple descriptive statistical analysis, the strength of strategic alignment 'A1', at corporate strategy level, was found to be between mixed (rating 3) and threshold (rating 4) with a mean of 3.65; whereas strategic alignment 'A2', at business processes/operations level, was quite significant with a mean of 4.05, an above average score (rating 6 signifies most significant alignment). Analysing the means of data captured showed that K1 (customer services), K4 (product quality), K5 (product/service leadership), K7 (revenue gain), K8 (cost saving) and K10 (sustainability of competitive advantages) were accorded above average (i.e., higher than rating 3) scores. The frequency distributions of the scores for 'A' and 'K' variables were also analysed to find out the frequencies of the ratings on A1 and A2 variables (the strength of business and IT linkage) and the rating on the effect of IT Systems on competitive advantage (K1-K9) and benefits (K10).

Correlations between the dependent and independent variables were analysed using the one-tailed Pearson method. It was found that K1 (customer services) had a significant correlation with A1 (strategic alignment at corporate strategy level); K4 (product quality) and K10 (sustainability of competitive advantages) had a significant correlation (at 0.05 level) with A2 (strategic alignment at business processes/operations level). It is to be noted that, when other data have been collected and collated, some inferential statistical methods will be used for further analyses in order to derive other meaningful relationships among the variables; for example, the relationship between cost saving and revenue generation and their impact on business-IT strategic alignment.

### 4. Findings and discussion

As indicated earlier, descriptive statistical analysis shows that the respondents perceived that their IT-strategy and IT-processes /operations alignment was above average (where, individually, A1 had a mean score of 3.65 and A2 had a mean score of 4.05). Most respondents appeared to be of the view that IT could bring above average benefits to business performance in the area of customer service, (K1 – mean score 3.59), product quality (K4 – mean score 3.92),

product & service leadership (K5 – mean score 3.03), revenue gain (K7 – mean score 3.19), cost saving (K8 – mean score 4.62) and sustainability of competitive advantages (K10 – mean score 3.24).

The frequency distributions analysis indicates that a total of 51% of the respondents regarded the alignment of IT strategy to corporate strategy as chaotic in their organisations, whilst a smaller number (27%) perceived the alignment of business process and operation to IT process and operation as chaotic. Only 14% of the respondents regarded the alignment of IT strategy to corporate strategy as harmonious in their organisations, whilst a larger number, at 41%, perceived the alignment of business process and infrastructure to IT process and infrastructure as harmonious or ideal in their organisations. The total score distributions among the K1 to K10 variables indicate that more than 40% of respondents thought IT could help them achieve better customer service (K1), product quality (K4), product/service leadership (K5), revenue gain (K7) and cost saving (K8). More than 50% said IT had no effect on employee loyalty (K2), time to market (K3), brand loyalty (K6), market share (K9) or on sustainability of competitive advantages or benefits obtained (K10).

When the relationships between strategic alignment (A1 and A2) and performance outcomes (competitive advantages, benefits and sustainability 'K' variables) were analysed, respondents were found to perceive that customer service (K1) had a direct positive relationship or link with IT-business alignment at corporate strategy level (A1); and product quality (K4) and competitive advantages sustainability (K10) were directly related with IT-business alignment at the process/operation level (A2).

The fourth research objective was posed as two hypotheses, namely:

- s *Hypothesis 1*: Tighter integration of IT-business at strategic level has a positive relationship with business performance.
- s *Hypothesis 2*: Tighter integration of IT-business at process/operation level has a positive relationship with business performance.

Table 2 below summarises the hypotheses tests.

**Table 2: Summary of hypothesis testing**

Competitive Advantages or Benefits	Hypothesis 1: tighter integration of IT-business at strategic level has a positive relationship with business performance	Hypothesis 2: tighter integration of IT-business at process/operation level has a positive relationship with business performance
K1	Supported	Not Supported
K2	Not Supported	Not Supported
K3	Not Supported	Not Supported
K4	Not Supported	Supported
K5	Not Supported	Not Supported
K6	Not Supported	Not Supported
K7	Not Supported	Not Supported
K8	Not Supported	Not Supported
K9	Not Supported	Not Supported
K10	Not Supported	Supported

It shows that even though more than 40% of respondents thought that IT could improve customer service (K1), product quality (K4), product/service leadership (K5), revenue gain (K7) and cost saving (K8), the correlation indicated that, with the exception of customer service (K1), there was no evidence to suggest that tighter integration of strategy and IT planning would yield higher performance outcomes for product quality (K4), product/service leadership (K5), revenue gain (K7) and cost saving (K8). Similarly, with the exception of product quality (K4) and competitive advantages sustainability (K10), there was no proof to suggest tighter integration between IT and business processes/operations would bring higher business performance outcome for customer service (K1), product/service leadership (K5), revenue gain (K7) and cost saving (K8).

## 5. Conclusions

In most cases, ensuring right inputs for the program or services, together with efficient activities and processes and effective outputs and outcomes performance measures is no guarantee for the success of a particular program or service. The recognition of logic before measurement will be a key element in the future success of performance management initiatives. The CSA model aims to provide a logic that integrates all the elements in the performance measures from inputs and processes through to outcome measures.

## References

- [1] Applegate, L.M., McFarlan, F.W. & Mckenney, J.L. *Corporate Information Systems Management: Text and Cases* Chicago: 4<sup>th</sup> edn, Richard D Irwin, 1996.
- [2] Arveson, P. "The Value of Corporate IT Initiatives: Category IV Competitive Advantage", <[http://www.balancedscorecard.org/bscit/value\\_add.html](http://www.balancedscorecard.org/bscit/value_add.html)>, 1998.
- [3] Bruce, K. "Can you align IT with business strategy?", *Strategy & Leadership* Nov./Dec., 1998.
- [4] Cresap, McCormick & Paget Co. *Information Systems Planning to Support Business Objectives: a Survey of Practices*, New York, Cresap, McCormick, and Paget Co., 1983.
- [5] Henderson, J.C. & Venkatraman, N., "Strategic alignment: leveraging information technology for transforming organizations", *IBM Systems Journal* Vol 1993, 32(1) pp 4-16.
- [6] Jang, S.Y. "Influence of Organizational Factors on Information Systems Strategic Planning" *Unpublished Dissertation*, University of Pittsburgh, 1989.
- [7] Luftman, J.N. *Competing in the Information Age: Strategic Alignment in Practice*, Oxford University Press, 1996.
- [8] Luftman, J.N., Papp, R. & Brier, T. "Enablers & inhibitors of Business-IT alignment", *Communications of the Association for Information Systems* (e-journal) Vol. 1, Article 11, March, 1999.
- [9] Maes, R. "Reconsidering Information Management Through a Generic Framework", *PrimaVera Working Paper*, 1999, 5 Sept.
- [10] Maes, R., Rijsenbrij, D., Truijen, O. & Goedvolk, H. "Redefining Business - IT Alignment Through A Unified Framework", *Joint University of Amsterdam & CAP Gemini Institute White Paper*, 2000.
- [11] McGee, J. & Prusak, L. *Managing Information Strategically*, The Ernst & Young Information Management Series, John Wiley & Sons, 1993.
- [12] Morton, M.S. *The Corporation of the 1990*, Oxford University Press, 1991.
- [13] Rumelt, R.P. *Strategy, Structure, and Economic Performance*, Harvard University Press, 1974.
- [14] Teo, T.S.H. "Integration between Business Planning and Information Systems Planning: Evolutionary-Contingency Perspectives", *Unpublished Dissertation*, University of Pittsburgh, 1994.

# Collectivism, Machiavellianism, Perceived Organizational Justice and Organizational Citizenship Behavior: An Empirical Study of Chinese Employees

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## Abstract

This study examined the relationship between perceived organizational justice and two individual differences, namely, (i) within-culture collectivism and (ii) Machiavellianism. In addition, this study also examined the influence of perceived organizational justice on organizational citizenship behavior (OCB). Previous research suggests that individual differences influence perceived organizational justice, which in turn have an effect on subsequent behaviors. However, much of the research was done in the western context. The present research seeks to examine the generalizability of findings based on the western context by investigating the relationships among within-culture collectivism, Machiavellianism, perceived organizational justice and OCB in a non-western context, specifically, among a group of employees from People's Republic of China. Results suggested that within-culture collectivism and Machiavellianism were significantly associated with perceived organizational justice. Consistent with previous research, perceived organizational justice was positively related to OCB. Implications of the study were discussed.

## 1. Introduction

Organizational justice refers to the degree to which the conduct of an organization toward its employees is perceived to be fair. It has attracted considerable attention from researchers in the area of organizational behavior in recent years. Two main issues have largely dominated research on organizational justice. First, researchers focused on individuals' reactions to situations of perceived organizational justice. Individuals' perceptions of "what is fair" determine their attitudes and behaviors toward organizations and supervisors, such as organizational citizenship behavior [2] [34], organizational commitment [33] [50, p.77], withdrawal [33] and retaliation [43]. Second, researchers have explored the antecedents of perceived organizational justice. As a kind of perception formed in organizational settings, perceived organizational justice is affected by perceivers' individual characteristics, such as personality [43], gender [21] [42] [46] and ethical frameworks [19]. However, research on this issue is still very limited.

The purpose of this study is to test prior theoretical assertions with regard to the influence of individual

characteristics on perceived organizational justice by examining whether two individual characteristics, namely, within-culture collectivism and Machiavellianism, affect perceived organizational justice.

In addition, the majority of research designed to address these two main issues was conducted in the western context. However, studies of the effects of perceived organizational justice do not provide consistent and mutually supportive conclusions as to the generalizability across cultures [27]. For example, findings in the American literature suggest that distributive justice more strongly related to job satisfaction than is procedural justice [31]. However, Yoon [57] found that among Korean employees procedural justice was more strongly related to job satisfaction than distributive justice. In a similar vein, Leung, Smith, Wang and Sun [30] found that the relationship between procedural justice and job satisfaction was more significant than that between distributive justice and job satisfaction in joint venture companies in China. The present research examined the relationship between perceived organizational justice and OCB among a group of Chinese employees.

## 2. Theoretical Background and Hypotheses

### 2.1 Perceived Organizational Justice

In the area of organizational behavior, perception is the process by which individuals select, organize and interpret the input from their senses to give meaning and order to the whole around them [23, p.108]. Through perception, people try to make sense of their environment and the objects, and other people in it. However, organizational researchers note that perception is influenced by characteristics of the perceiver. Among the characteristics are motivational states [23, p.108] [24, p.31]. Specifically, the perceiver's needs, values and desires influence his perception of the objects that he perceives.

Perceived organizational justice is a kind of perception that reflects employees' senses of decisions, decision-making procedures and supervisors in organizational settings. There are three dimensions of organizational justice, i.e., distributive, procedural and interactional justice. Distributive justice refers to the fairness of outcomes or allocations that an individual receives [20].

It reflects employees' perception of whether they are fairly paid in comparison with their input into work. Further, a substantial amount of research on organizational justice has suggested that people, when reacting to organizational decisions that affect them, are influenced by the procedures used to determine the decision outcomes. In other words, people concern with the fairness of the decision-making procedures, labeled as procedural justice [28] [47]. The most recent advance in the justice literature is to focus on the importance of the quality of the interpersonal treatment people receive when procedures are implemented, labeled as interactional justice [4]. Interactional justice reflects supervisors' respect and consideration to employees.

Since a perceiver's motivational states influence his perception, it is suitable for this study to examine effects of within-culture collectivism and Machiavellianism on organizational justice perception. As illustrated in the following section, both within-culture collectivism and Machiavellianism fully reflect individual internal values and desires. Thus they are expected to influence employees' different understanding of the organizational decisions, decision-making procedures and supervisors.

## 2.2 Individual Differences and Perceived Organizational Justice

Individualism-collectivism (IC) has been regarded as a way to distinguish between individuals who are oriented towards self-interests and concern with achieving their own goals and individuals who are oriented toward the collective and focus on the social system rather than themselves [40]. Although prior research suggests that IC is a cross-cultural variable, many cross-cultural researchers note that there may be considerable within country variability along cultural dimensions [14] [32] [49]. IC has been directly measured within culture to indicate individualistic or collectivistic characteristic and further to predict changes in the outcomes of interests [16] [17] [36]. In general, collectivists place collective interests and interpersonal harmony above self-interests. In contrast, the pursuit of individual outcomes and independence is a principal motivation of individualists [48, p.41].

To date, distributive justice researchers have investigated different preferences among reward allocation norms (e.g., equity, equality, and need) across individualistic and collectivistic cultures. They found that collectivists tend to prefer equality and/or need norms to equity norm while individualists tend to prefer equity norm to quality or need norms. Although the specific relationship between IC and perceived distributive justice has not been empirically examined, researchers proposed that the value system of collectivists determines their tendency to seek collective outcomes instead of pursuing individual outcomes. In contrast, individualists tend to place their priority on the recognition of individual achievement and contribution [6]. Further, Choi [6] suggested that outcomes of decision-making be grouped into individual outcomes and group outcomes in order to

explore the influence of IC on perceived distributive justice.

The distributive justice scale in the extant organizational justice literature is used to measure employees' fairness perception of their individual outcomes (e.g., individual payment and bonus) and does not reflect that of the group outcomes (e.g., group bonus). Building upon Choi's proposition about the classification of group and individual outcomes, and collectivists' value system of concerning with collective interests, this study will examine the specific relationship between collectivism and employees' perception of their individual payment, as is assessed by the distributive justice scale in the majority of justice literature. It is expected that collectivists would care less about individual outcomes than about group outcomes. Thus, it is hypothesized that:

H1a: Collectivism is negatively associated with perceived distributive justice.

Cross-cultural research on procedural justice has addressed the question that non-westerners (i.e., collectivists) also care about the procedural justice issues [45]. In addition, some research examined the different preference for conflict resolution procedures between individualists and collectivists [29]. Although these studies did not demonstrate the specific association between IC and perceived procedural justice, they did suggest that collectivism would influence perception of procedural justice.

Research on the different information-processing styles of individualists and collectivists can help us better understand how collectivism is related to perceived procedural justice [15] [16] [18]. According to Earley et al [18] the information processing styles of collectivists and individualists determine the relative salience of self or group. In contrast to individualists, collectivists tend to focus on group-orientated information and display group-related cognition, for example, their value as a group member.

Further, group value theory helps to provide insights regarding the process which link procedural justice and group membership within the organization [26]. Group value theory suggests that people have a sense of affiliation with groups and they assess their value as a group member by the organizational procedures [51]. In an organization when both collectivistic and individualistic employees are influenced by the same organizational procedures, collectivists' stronger sense of affiliation with groups is expected to motivate a correspondingly stronger perception of procedural justice than that of individualists. Thus, it is hypothesized:

H1b: Collectivism is positively associated with perceived procedural justice.

Collectivists value interpersonal harmony with other group members, especially with supervisors. This value motivates them to pay attention to the information about the quality of the interpersonal treatment from the supervisors. In contrast, individualists value independence more than interpersonal relationship. Given that supervisor treat every employee equally with respect

and consideration, the tendency of collectivistic employees to focus on the information about the quality of their relationship with the supervisors will motivate them to form a stronger perception of interactional justice than does the tendency of individualistic employees. Thus, it is hypothesized that:

H1c: Collectivism is positively associated with perceived interactional justice.

Another motivational variable we want to examine is Machiavellianism, a construct that has been rather extensively examined in the psychological literature. Machiavellianism refers to a strategy of social conduct that involves manipulating others for personal gains, often against the interests of others [55]. Previous research has often associated Machiavellianism with such characteristics as selfishness, deceit and manipulateness [13] [22] [55]. Both the definition and the description of Machiavellianism suggest its association with the self-interest value system and the tendency to exploit others. Machiavellianism is found to bear the following characteristics: (1) a lack of affect in interpersonal relationships; (2) a lack of concern with conventional morality; and (3) low ideological commitment [10, p.1].

Christie and Geis [8, p.959] [9] [11, p.163] were among the first scholars to measure individuals' Machiavellianism tendencies. People with high Machiavellianism, namely, high-Machs, tend to focus on potential gains for themselves. They are not concerned with conventional morality and are particularly likely to lie and cheat when given opportunities [13]. High-Machs' focus on their potential and individual interests reflects their strong desire for individual outcomes and achievements. Because high-Machs are not easily satisfied, it is reasonable for us to expect that high-Machs always feel that they are unfairly paid. Thus, it is hypothesized that:

H2a: Machiavellianism is negatively associated with perceived distributive justice.

Further, high-Machs tend to focus on direct and visible individual outcomes (e.g., material reward) and are not interested in the intangible benefits contained in the decision-making procedures, for example, their value as group members to voice. When the procedures cannot bring high-Machs direct and visible material benefits in the near future, they are more likely than low-Machs to perceive the procedures to be unjust. Thus, it is hypothesized that:

H2b: Machiavellianism is negatively associated with perceived procedural justice.

An important characteristic of high-Machs is their tendency to manipulate others. Research has found that high-Machs employ deceptive strategy of exploitation in their short-term social interaction. In other words, high-Machs always want to be in a dominant position in their interpersonal relationship with others. However, this desire to dominate other people in social interaction clearly conflicts with the existing hierarchical subordinate-supervisor relationship in organizations. We note that the fair treatment and respect from a supervisor does not mean that the hierarchal relationship between

supervisors and employees no longer exists. It is supervisors who always stay in a dominant position in the hierarchical relationship. Thus, when high-Machs' desire of dominant status in social interaction cannot be met, we can expect that high-Machs tend to feel an unfair treatment from the supervisors. Thus, it is hypothesized that:

H2c: Machiavellianism is negatively associated with perceived interactional justice.

## 2.3 Perceived Organizational Justice and Organizational Citizenship Behavior (OCB)

Organizational citizenship behavior (OCB) refers to discretionary behavior that is not part of an employee's job description. OCB is not explicitly related to the formal reward system of an organization but is conducive to its effective functioning [38]. Organ [39] posited that citizenship behaviors are driven largely by perceptions of justice. Previous research suggests that employees who believe that they are fairly treated are more likely to hold positive attitudes about their work, their coworkers and supervisors. In turn, they are also more likely to reciprocate by engaging in citizenship behaviors to benefit their organization [35]. Empirical research has demonstrated significant relationship between three dimensions of organizational justice and OCB [1] [33] [37]. Moreover, research on OCB has consistently demonstrated stronger linkages between perceived procedural justice and OCB than between perceived distributive justice and OCB [2] [34]. For example, Moorman [34] reported that perceived procedural justices influenced four of five OCB dimensions, whereas perceived distributive justice did not affect any of justice dimensions [12].

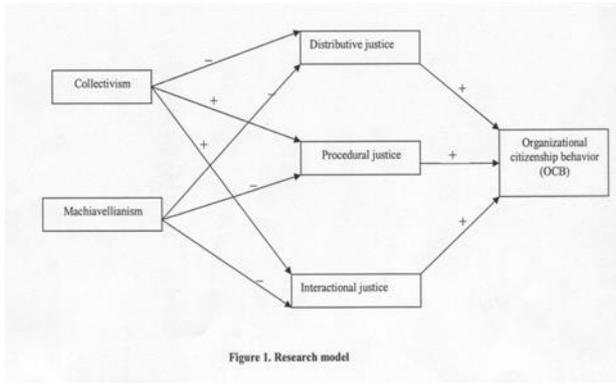
At the same time, we note that the majority of research on these relationships was conducted in the western context. Further examination of these relationships in the eastern context will enable us to understand the impact of perceived organizational justice on work-related outcomes. It is hypothesized that:

H3a: Perceived distributive justice is positively associated with organizational citizenship behavior.

H3b: Perceived procedural justice is positively associated with organizational citizenship behavior.

H3c: Perceived interactional justice is positively associated with organizational citizenship behavior.

Figure 1 illustrates the proposed relationships among two individual differences (i.e., within-culture collectivism and Machiavellianism), three dimensions of perceived organizational justice (i.e., distributive, procedural and interactional justice) and organizational citizenship behavior (OCB). It provides an overview of this study.



### 3. Method

#### 3.1 Sample

Data were collected via the use of electronic questionnaire. Respondents were professional employees from 10 IT-related companies in Xiamen city of the mainland China. The electronic questionnaire containing a cover letter to explain the aim of this survey was sent to respondents.

A total of 97 completed surveys were collected. About 51% of the respondents were women. The average age of respondents was about 30 years (S.D. = 5.29). The average organizational tenure was 4.54 years (S.D. = 4.38).

#### 3.2 Measures

**Collectivism.** An eight-item scale ( $\alpha = 0.65$ ) developed by Earley [17] was used to measure the respondent's tendencies to be collectivistic or individualistic within culture. Items were scored from (1) Strongly Disagree to (5) Strongly Agree. Examples of items in this scale include: 'If the group is slowing me down, it is better to leave it and work alone'; 'One does better work working alone than in a group'; and 'I would rather struggle through a personal problem by myself than discuss it with my friends'. High scores on this scale suggest high level of collectivism.

**Machiavellianism.** A twenty-item scale ( $\alpha = 0.77$ ) developed by Christie and Geis [10, p.1] was used to assess respondents' Machiavellianism. Items were scored from (1) Very Strongly Disagree to (7) Very Strongly Agree and tapped respondents' opinions on three substantive areas, namely, Machiavellian views, tactics and morality. Examples of items include: 'Never tell anyone the real reason you did something unless it is useful to do so'; 'The best way to handle people is to tell them what they want to hear'; and 'Honesty is the best policy in all cases'. The higher the scores, the stronger the respondents' Machiavellianism orientation.

**Organizational justice.** The three justice variables were measured using scales developed by Moorman [34]. Distributive justice was measured with five items ( $\alpha = 0.92$ ) pertaining to individuals' perceptions of the extent to which they have been fairly rewarded by their

organizations based on times such as: 'The responsibilities you have'; 'The stress and strains of your job'; and 'The work that you have done well'.

Procedural justice was assessed with seven items ( $\alpha = 0.93$ ) pertaining to respondents' perceptions regarding the fairness of organizational procedures. Examples of items include: 'How fairly are the organizational procedures designed to (a) provide opportunities to appeal against or challenge a company's decision; (b) hear the concerns of everyone affected by a company's decision; and (c) generate standards so that decisions can be made with consistency'. Items were scored on a five-point scale ranging from (1) Very Unfair to (5) Very Fair.

The scale for interactional justice included six items ( $\alpha = 0.93$ ) pertaining to whether organizational procedures were enacted properly and fairly by supervisors. Items, which were scored on a 5-point scale ranging from (1) Strongly Disagree to (5) Strongly Agree, include: 'My supervisor (1) provides me with timely feedback about decisions and their implications; (2) is able to suppress personal bias; and (3) treats me with kindness and consideration'.

**Organizational citizenship behavior (OCB).** This variable was assessed through a self-report version of 16-item scale ( $\alpha = 0.78$ ) developed by Smith, Organ, and Near [44]. Items were scored from (1) Strongly Disagree to (5) Strongly Agree. Examples of items include: 'Help others who have been absent'; 'Make innovative suggestions to improve department'; and 'Attend functions which are not required of me but help to improve company's image'. High scores on this scale mean respondents' high engagement in citizenship behaviors.

### 4. Results

Descriptive statistics, correlations and Cronbach's alpha values are reported in Table 1.

Variables	M	S.D.	1	2	3	4	5	6
1. Collectivism	3.26	0.50	(0.65)					
2. Machiavellianism	3.93	0.53	-0.46**	(0.77)				
3. Distributive justice	2.96	0.75	0.33**	-0.40**	(0.92)			
4. Procedural justice	3.27	0.89	0.20*	-0.28**	0.40**	(0.93)		
5. Interactional justice	3.29	0.75	0.42**	-0.40**	0.42**	0.53**	(0.93)	
6. OCB	3.62	0.41	0.31**	-0.48**	0.16	0.33**	0.42**	(0.78)

N=97. The numbers in parentheses on the diagonal are coefficient alphas.  
\* Correlation is significant at the 0.05 level (1-tailed).  
\*\* Correlation is significant at the 0.01 level (1-tailed).

Hypothesis 1a, which predicted that collectivism was negatively associated with perceived distributive justice of individual outcomes, was not supported. In contrast, collectivism was positively related to respondents' justice perception of their individual outcomes ( $r = 0.33$ ,  $p < 0.01$ ). Hypothesis 3a about the positive relationship between perceived distributive justice and OCB was not significant ( $r = 0.16$ ,  $p > 0.05$ ). As predicted, all the other hypotheses were significantly supported. Results suggest that collectivism has a significant positive association

with OCB ( $r = 0.31, p < 0.01$ ) yet Machiavellianism has a negative association with OCB ( $r = -0.48, p < 0.01$ ).

**Table 2. Results of hierarchically regressing perceived organizational justice on the control and independent variables (N = 97)**

Variables	Distributive justice		Procedural justice		Interactional justice	
	Beta*	$\Delta R^2$	Beta	$\Delta R^2$	Beta	$\Delta R^2$
<b>Control</b>						
Gender	0.04		-0.16		-0.06	
Age	0.17		-0.20		0.11	
Tenure	-0.03	0.02	-0.05	0.07	-0.33*	0.07
<b>Individual differences</b>						
Collectivism	0.20*		0.22*		0.29**	
Machiavellianism	-0.29*	0.18	-0.29*	0.10	-0.26*	0.21
$R^2 = 0.20$ ; Adj. $R^2 = 0.15$ $R^2 = 0.17$ ; Adj. $R^2 = 0.13$ $R^2 = 0.28$ ; Adj. $R^2 = 0.24$ $F = 9.60$ (2, 88), $p = 0.00$ $F = 5.36$ (2, 88), $p = 0.00$ $F = 12.96$ (2, 88), $p = 0.00$						

\* Standardized beta coefficients in the overall regression equation.  
\*  $p < 0.05$ , \*\*  $p < 0.01$ .

The hypothesized relationships between the individual characteristics, namely, within-culture collectivism and Machiavellianism, and perceived organizational justice were further examined using hierarchical regression analyses. The results in Table 2 suggest that the influences of collectivism and Machiavellianism on perceived organizational justice were still very significant, even with the control of the three demographic variables. Collectivism and Machiavellianism totally accounted for 18% of the variance in distributive justice, 10% in procedural justice and 21% in interactional justice.

**Table 3. Results of hierarchically regressing organizational citizenship behavior on the control and independent variables (N = 97)**

Variables	Organizational citizenship behavior (OCB)	
	Beta*	$\Delta R^2$
<b>Control</b>		
Gender	0.05	
Age	0.25*	
Tenure	-0.07	0.05
<b>Organizational justice</b>		
Distributive justice	0.11	
Procedural justice	0.27*	
Interactional justice	0.40**	0.25
$R^2 = 0.30$ ; Adj. $R^2 = 0.25$ $F = 10.51$ (3, 87), $p = 0.00$		

\* Standardized beta coefficients in the overall regression equation.  
\*  $p < 0.05$ , \*\*  $p < 0.01$ .

Results of hierarchical regression analysis in Table 3 suggest that perceived distributive justice has no effect on OCB (Beta = 0.11,  $p > 0.05$ ). However, both procedural justice and interactional justice are strong predictors of employees' engagement in OCB. Even after the demographic variables were controlled, these two dimensions of justice perception explained 25% of the variance in OCB.

## 5. Discussion

First, results of this study suggest that individual differences can significantly influence perceived organizational justice. Specifically, within-cultural

collectivism and Machiavellianism have a significant association with three dimensions of perceived organizational justice. Given that collectivistic and individualistic employees stay in the same organization with equal decision-making procedures and equal treatment from supervisors, collectivistic employees are more likely than their counterparts to form fairness perception.

Statistical analyses showed that there is a significant relationship between within-culture collectivism and perceived organizational justice. The significant positive association between collectivism and procedural justice as well as interactional justice exactly reflects the value system of collectivists. However, collectivism was found to be positively related to distributive justice which measured respondents' perception of their individual payment in this study. This result is completely contrary to Choi's proposition [6] about the relationship between collectivism and individual outcomes. In other words, this study showed that collectivistic employees also concerned with individual outcomes. There are two possible explanations for this result. First, the distributive justice scale to assess employees' perception of their individual payment actually reflects an organization's distribution system that affects every employee equally. In other words, the fairness of the distribution system is a common interest to all employees. Thus, it is reasonable for collectivistic employees to form fairness perception of the distribution system for individual payment. Earley et al [18] argued that a collectivist's sense of self is based on both personal and group-based information. Not only does a collectivist benefit from knowing that his or her work group has been successful, but he or she needs to know about personal success as well. In a similar vein, it is reasonable for this study to find that collectivism has a positive association with justice perception of individual outcomes. Second, the respondents in this study were Chinese employees, whose value system increasingly changed with the goal priority shift in Chinese enterprises during the two decades of economic reforms in China [7]. Before the economic reforms in 1978, the objectives of Chinese enterprises were more sociopolitical and ideological than economic [25] [53]. This goal priority of Chinese enterprise was accompanied with individual payment to be officially determined by the bureaucracy. Thus, it was impossible for Chinese employees to care about their individual outcomes. Since 1978, the economic reforms have reduced traditional state protection for Chinese enterprises and motivated them to take responsibility for their own survival in the increasingly competitive open markets. Simultaneously, the drastic shift from sociopolitical to economic goals in Chinese enterprises has generated enormous psychological effects on Chinese employees. Chinese employees are allowed to focus on individual outcomes, which generally reflect their performance or ability. At the same time, we should note that Chinese employees still keep the traditionality to consider collective interest and interpersonal harmony of importance. Thus, the simultaneous influence of both the collectivistic tradition

and the economic reforms in modern China makes it reasonable that Chinese employees not only care about individual outcomes as well as group outcomes.

To date, little is known about the relationship between Machiavellianism and perceived organizational justice. As an important psychological construct that reflects individual inner value, Machiavellianism should be promising to predict perception. The result of this study fully demonstrated a significant negative effect of Machiavellianism on perceived organizational justice. High-Machs' focus on self-interests and their nature to manipulate others determine their tendencies to form unfair perception of outcome distribution, decision-making procedures and supervisor treatment in an organization.

Second, the result of the relationship between perceived organizational justice and OCB provides support for previous western-based research. Specifically, this study demonstrated a stronger predictive power of procedural justice than of distributive justice. Therefore, western-based findings about the relationship between perceived organizational justice and OCB are generalizable to the eastern context.

Third, this study provides insights into individual differences, namely, within-culture collectivism and Machiavellianism, as predictors of OCB, although we did not illustrate the relationships between individual differences and OCB in detail. The significant positive correlation between within-culture collectivism and OCB ( $r = 0.31, p < 0.01$ ) provides strong support for previous research on the influence of within-culture collectivism on OCB [36] [52]. Moorman and Blakely [36] found that within-culture collectivism is positively related to specific dimensions of OCB. Van Dyne et al [52] confirmed the result. Likewise, the additional finding about the significant negative relationship between Machiavellianism and OCB ( $r = -0.48, p < 0.01$ ) casts light on the possibility to examine whether Machiavellianism is a possible predictor of OCB. Wilson, Near and Miller [55] pointed out that high-Machs and low-Machs differ in many aspects of their behaviors. Moreover, previous research on workplace deviance has demonstrated a positive correlation between Machiavellianism and deviant behaviors, i.e., the anti-citizenship behaviors [3]. Therefore, it is reasonable for future study to examine the specific influence of Machiavellianism on OCB.

## 6. Implications

## References

[1] Aryee, S., Budhwar, P.S. & Chen, Z.X. "Trust as a mediator of the relationship between organizational justice and work outcomes: Test of a social exchange model," *Journal of Organizational Behavior*, 2002, 23(3), 267-285.

[2] Ball, G.A., Trevino, L.K. & Sims, H.P. "Justice and unjust punishment: Influences on subordinate performance and citizenship," *Academy of Management Journal*, 1994, 37(2), 299-322.

Results of this study have both theoretical and practical implications. In terms of the theoretical implications, this study extends previous research on the influence of individual differences on perceived organizational justice by examining the association between within-culture collectivism and Machiavellianism and perceived organizational justice. Moreover, findings of this study do not differ from those based on the western context and provide support for the theoretical argument that justice perception is a potent predictor of OCB.

In terms of the practical implications, organizations may want to increase employees' justice perception because it plays a key role in motivating employees to engage in OCB while reducing deviant behaviors. Justice perceptions are influenced not only by individual differences but also by organizational structures, procedures and organizations. Therefore, organizations should create a favorable working environment, which sets stage for employees' perceived organizational justice. Organizations can, to some degree, assess job candidates' individual differences in recruitment process to predict their tendencies to engage in citizenship behaviors as well.

## 7. Limitations and Future Research

One limitation of this study is that data were self-reported. Although self-report has been used by research on OCB [5] [41], it would be ideal to obtain data from multiple sources. The problem with the use of self-reports is self-serving bias on the part of the respondents who wish to appear to be good citizens [38] and a ceiling effect, whereby OCB scores are clustered at the positive end of the scale.

This study examined the effect of individual differences, namely, within-culture collectivism and Machiavellianism, on perceived organizational justice and the relationship between justice perception and OCB among a group of Chinese employees. Future studies can examine whether organizational justice is a mediator of the relationship between individual differences and OCB. Niehoff and Moorman [37] demonstrated that justice mediated the relationship between methods of monitoring and OCB. Their study found that methods of monitoring had a negative direct effect on OCB and a positive indirect effect through three dimensions of perceived organizational justice as well. Future studies can also examine whether Machiavellianism is predictor of employees' reluctance to engage in citizenship behaviors.

[3] Bennett, R.J. & Robinson, S.L. "Development of a measure of workplace deviance," *Journal of Applied Psychology*, 2000, 85(3), 349-360.

[4] Bies, R.J. & Moag, J.F. "Interactional justice: Communication criteria of fairness," *Research on Negotiations in Organizations*, 1986, 1(1), 43-55.

[5] Chattopadhyay, P. "Beyond direct and symmetrical effects: The influence of demographic dissimilarity on organizational

- citizenship behavior," *Academy of Management Journal*, 1999, 42(3), 273-287.
- [6] Choi, J. "Determinants of procedural justice perceptions: The role of outcome favorability, procedural characteristics and individualism-collectivism," Paper presented at the Academy of Management Meeting, Denver, 2002.
- [7] Cheng, C. "New trends in rewards allocation preferences: A Sino-U.S. comparison," *Academy of Management Journal*, 1995, 38(2), 408-428.
- [8] Christie, R. & Geis, F. "Some consequences of taking Machiavellianism seriously," In E.F. Borgotta & W.W. Lambert (Eds.) *Handbook of Personality Theory and Research*, Chicago: Rand McNally, 1968.
- [9] Christie, R. & Geis, F. *Studies in Machiavellianism*. NY: Academic Press, 1970a.
- [10] Christie, R. "Why Machiavelli?" In R. Christie & F. Geis (Eds.), *Studies in Machiavellianism*, 1970a.
- [11] Christie, R. & Geis, F. "The ten dollar game," In R. Christie & F. Geis (Eds.), *Studies in Machiavellianism*, 1970b.
- [12] Colquitt, J.A., Conlon, D.E., Wesson, M.J., Porter, C.O.L.H. & Ng, K.Y. "Justice at the millennium: A meta-analytical review of 25 years of organizational justice research," *Journal of Applied Psychology*, 2001, 86(3), 425-445.
- [13] Cooper, S. & Peterson, C. "Machiavellianism and spontaneous cheating in competition," *Journal of Research in Personality*, 1981, 14(1), 70-75.
- [14] Cross, S.E. & Madon, L. "Models of the self: Self-construals and gender," *Psychological Bulletin*, 1997, 122(1), 5-37.
- [15] Earley, P.C. "Information mechanisms of participation influencing goal acceptance, satisfaction and performance," Unpublished doctoral dissertation, University of Illinois, Champaign, 1984.
- [16] Earley, P.C. "Social loafing and collectivism: A comparison of the United States and the People's Republic of China," *Administrative Science Quarterly*, 1989, 34(4), 565-581.
- [17] Earley, P.C. "East meets West meets Mideast: Further explorations of collectivistic and individualistic work groups," *Academy of Management*, 1993, 36(2), 319-348.
- [18] Earley, P.C., Gibson, C.B. & Chen, C.C. "'How did I do?' versus 'How did we do?': Cultural contrasts of performance feedback use and self-efficacy," *Journal of Cross-cultural Psychology*, 1999, 30(5), 594-619.
- [19] Folger, R. "Reformulating the preconditions of resentment: a referent cognitions model," In Masters, J.C., & Smith, W.P., (Eds.) *Social Comparison, Social Justice, and Relative Deprivation*, 1987.
- [20] Folger, R. & Cropanzano, R. *Organizational Justice and Human Resource Management*. Thousand Oaks, CA: Sage, 1998.
- [21] Greenberg, J. "Looking fair vs. being fair: managing impression of organizational justice," *Research in Organizational Behavior*, 1990, 12, 111-157.
- [22] Geis, F.L. & Moon, T.H. "Machiavellianism and deception," *Journal of Personality and Social Psychology*, 1981, 41(4), 766-775.
- [23] George, J.M. & Jones, G.R. *Understanding and Managing Organizational Behavior*. Second Edition, 1998.
- [24] Gordon, J.R. *A Diagnostic Approach to Organizational Behavior*. Fourth Edition, 2000.
- [25] Jackson, S. *Chinese Enterprise Management*. New York: Walter de Gruyter, 1992.
- [26] Jane, G.M. "A test of the group values and control models of procedural," *Personnel Psychology*, 1995, 48(1), 115-130.
- [27] Lam S.S.K., Schaubroeck, J. & Aryee, S. "Relationship between organizational justice and employee work outcomes: a cross-national study," *Journal of Organizational Behavior*, 2002, 23(1), 1-18.
- [28] Leventhal, G.S., Karuza, J. & Fry, W. R. "Beyond fairness: A theory of allocation preferences," *Justice and Social Interaction*, 1980, 167-218.
- [29] Leung, K. & Lind, E.A. "Procedural justice and culture: Effects of culture, gender, and investigator status on procedural preferences," *Journal of Personality and Social Psychology*, 1986, 50(6), 1134-1140.
- [30] Leung, K., Smith, P.B., Wang, Z.M. & Sun, H. "Job satisfaction in joint venture hotels in China: an organizational justice analysis," *Journal of International Business Studies*, 1996, 27(5), 947-962.
- [31] Lind, E.A. & Tyler, T.R. *The Social Psychology of Procedural Justice*. New York: Plenum, 1988.
- [32] Markus, H.R. & Kitayama, S. "Culture and self: Implications for cognition, emotion and motivation," *Psychological Review*, 1991, 98(2), 224-253.
- [33] Masterson, S.S., Lewis, K., Goldman, B.M. & Taylor, M.S. "Integrating justice and social exchange: The differing effects of fair procedures and treatment on work relationships," *Academy of Management Journal*, 2000, 43(4), 738-748.
- [34] Moorman, R.H. "Relationship between organizational justice and organizational citizenship behaviors: Do fairness perceptions influence employee citizenship?" *Journal of Applied Psychology*, 1991, 76(6), 845-855.
- [35] Moorman, R.H., Niehoff, B.P. & Organ, D.W. "Treating employees fairly and organizational citizenship behavior: sorting the effects of job satisfaction, organizational commitment and procedural justice," *Employee Responsibilities and Rights Journal*, 1993, 6, 209-225.
- [36] Moorman, R.H. & Blakely, G.L. "Individualism-collectivism as an individual difference predictor of organizational citizenship behavior," *Journal of Organizational Behavior*, 1995, 16(2), 127-142.
- [37] Niehoff, B.P. & Moorman, R.H. "Justice as a mediator of the relationship between methods of monitoring and organizational citizenship behavior," *Academy of Management Journal*, 1993, 36(3), 527-556.
- [38] Organ, D.W. *Organizational citizenship behavior: the good soldier syndrome* Lexington, MA: Lexington Books, 1988.
- [39] Organ, D.W. "The motivational basis of organizational citizenship behavior," *Research in Organizational Behavior*, 1990, 12, 43-72.
- [40] Parshons, T. & Shills, E.N. *Toward a General Theory of Social Action*, Harvard University Press, Cambridge, 1951.
- [41] Pierce, J., Gardner, D., Cummings, L. & Dunham, R. "Organization-based self-esteem: Construct definition, measurement, and validation," *Academy of Management Journal*, 1989, 32(3), 622-648.
- [42] Ramona, B.D. & Farrell, A.C. "Sex-based promotion decisions and interactional fairness: Investigating the influence of managerial accounts," *Journal of Applied Psychology*, 1996, 81(1), 1-22.
- [43] Skarlicki, D.P. "Personality as a moderator in the relationship between fairness and retaliation," *Academy of Management Journal*, 1999, 42(1), 100-108.
- [44] Smith, F.J., Organ, D.W. & Near, J.P. "Organizational citizenship behavior: Its nature and antecedents," *Journal of Applied Psychology*, 1983, 68(4), 653-663.
- [45] Sugawara, I. & Huo, Y.J. "Disputes in Japan: A cross-cultural test of the procedural justice model," *Social Justice Research*, 1994, 7(2), 129-144.
- [46] Sweeney, P.D. & McFarlin, D.B. "Process and outcome: gender difference in the assessment of justice," *Journal of Organizational Behavior*, 1997, 18(1), 83-98.

- [47] Thibaut, J. & Walker, L. "Procedural Justice: A psychological justice," *Applied Social Psychology in Business*, 1975, 77-98.
- [48] Triandis, H.C. "Cross-cultural studies of individualism and collectivism," In J.Berman (Eds.), *Nebraska symposium on motivation*, 1990.
- [49] Triandis, H.C., Bontempo, R., Villareal, M.J., Asai, M. & Laccu, N. "Individualism and collectivism: Cross-cultural perspectives on self-ingroup relationships," *Journal of Personality and Social Psychology*, 1988, 54(2), 323-338.
- [50] Tyler, T.R. & Bies, R.J. "Beyond formal procedures: The interpersonal context of procedural justice," In J.S. Carroll (Eds.). *Applied Social Psychology and Organizational Settings*, 1990.
- [51] Tyler, T.R. & Lind, E.A. "A relational model of authority in groups," In M. Zanna (Eds.), *Advances in Experimental Social Psychology*, 1992, 25, 115-191.
- [52] Van Dyne L., Vandewalle, D., Kostova, T., Latham, M.E. & Cummings, L.L. "Collectivism, propensity to trust and self-esteem as predictors of organizational citizenship in a non-work setting," *Journal of Organizational Behavior*, 2000, 21(1), 3-23.
- [53] Walder, A.G. *Communist Neo-traditionalism*. Berkeley: University of California Press, 1986.
- [54] Wayne, S., Shoore, L. & Liden, R. "Perceived organizational support and leader-member exchange: A social exchange perspective," *Academy of Management Journal*, 1997, 40(1), 82-111.
- [55] Wilson, D.S., Near, D.C. & Miller, R.R. "Machiavellianism: A synthesis of the evolutionary and psychological literatures," *Psychological Bulletin*, 1996, 119(2), 285-299.
- [56] Wilson, D.S., Near D.C. & Miller, R.R. "Individual differences in Machiavellianism as a mix of cooperative and exploitative strategies," *Evolution and Human Behavior*, 1998, 19(3), 203-212.
- [57] Yoon, J.K. "Fairness issues and job satisfaction among Korean employees: the significance of status and procedural justice in work orientation," *Social Justice Research*, 1996, 9(2), 121-143.

# Applying Business Models for Risk Management in E-Business

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## Abstract

This paper presents a case study of the application of business models for managing risk in the development of operational strategies for e-business. It includes issues of security, transaction protection, customer relationships, and data and content ownership. The investment that an e-business project is willing to make in risk management activities depends on the business model adopted, the experience of the project team, and the constraints imposed on both. This is particularly important when planning to use technology to do business in the global economy.

## 1. Introduction

In this paper e-business models, e-business development and operation strategies are examined within the framework of project risk management. A case study of a practical approach to project risk management is used to illustrate a specific project development strategy available to organisations working within the e-business environment.

## 2. Defining Project Risk

Project risk management is the practice of identifying, assigning, and responding to risk throughout the life of a project and with the goal of meeting project objectives [8, p.302]. Risk management can improve the process of selecting projects, determining the scope of project, and developing schedules and cost estimates. It assists project stakeholders understand the nature of the project, and encourages integration of the other project management knowledge areas.

Risk in itself is not bad; risk is essential to progress, and failure is often a key part of learning [3, p.172]. A project must balance the possible negative consequences of risk against the potential benefits of its associated opportunity. In many respects, risk management is similar to insurance. Schwalbe [8, p.303] defines it as an activity undertaken to lessen the impact of potentially adverse events on a project. Like insurance, risk management is an investment with associated costs. The level of this investment is dependent upon the nature of the project, the experience of the project team, and the constraints imposed on both.

Why do organisations continue to undertake e-business projects if they are subject to risk and may cause loss or injury? Schwalbe [8, pp.303-304] observes that many companies are in business today because they took

risks that created great opportunities. Organisations survive over the long term when they pursue opportunities based upon innovation [5]. E-business may now be a key part of a business's strategy; without it many businesses might not survive. However, Greenstein and Feinman [3, p. 172] warn "In the rush to deploy client/server and Web-related technologies and perhaps gain competitive advantage or generate higher revenue along the way few companies stop to consider that these systems may expose them to some operational and financial risks".

## 3. E-Business and Risk

Faced with the necessity to engage in new forms for business based upon information technology, organisations are finding that there are two major e-business risk issues - security and the protection of transactions. In addition, these organisations must also consider the potential difficulties that they may have in adopting e-business technology and the specific threats that e-business present to the organisations.

### 3.1 Security

Currently, the major barrier to e-business is the consumer's lack of confidence in Internet security [7, p.158]. For e-business to be trustworthy, it must be secure and reliable. Users must feel confident when revealing sensitive information like credit card details that this information will be kept safe and secure.

Security is a constant consideration of any network-based application. It must address the following issues while still providing users access to the information:

- Authentication,
- Access control,
- Firewalls, and
- Encryption.

Firewalls are a combination of software and hardware, which manage access between a company's internal system and the Internet [3, pp.158-159]. A firewall allows a network administrator to determine which services and types of information are accessible through your Internet connection. Firewalls must be used in conjunction with an overall security policy to be most effective.

Encryption can be used after data has left an internal system. Encryption renders the data unreadable by using a mathematical formula known as a key. The data is turned back into readable form, i.e. deciphered, by

applying the correct key. Secure payment systems that people trust are pivotal to the continued growth of e-business. New payment systems like digital checks and electronic wallets are currently being developed, but credit cards are still the most common form of payment [7, p.239]. To set up a credit card payment system on your web site you need:

- An acquiring bank that will establish an Internet merchant account
- Payment processing software to transfer the credit card details between your bank and web site
- A secure certificate for data encryption

The most common encryption protocol in current use is SSL (Secure Sockets Layer) that was developed by Netscape [6]. SET (Secure Electronic Transactions) sponsored by Visa and MasterCard is another encryption technology, which is a new standard to enable secure credit card transactions on the Internet [9].

However, Greenstein and Feinman [3, p.158] and Schneider and Perry [7, p. 162] emphasise that effective Internet security requires policy as well as technology. A good security policy will ensure:

- Safety - that sensitive information sent across the Internet is protected during transit
- Trust - that information reaches its destination without tampering
- Privacy - that personal information stored is available only to authorised personnel

Questions to ask when developing your policy include:

- Who needs to have Internet and e-mail access?
- Do staff check email and fax numbers before sending confidential information?
- Are sensitive documents encrypted before being transmitted?
- Are parts of your internal computer system restricted?
- What do you do when employees leave? Do you have a password policy?

Security is about an approach to information management. In particular, protection of confidential client information is going to become more important as companies gather more information about clients through doing business on the Internet.

### 3.2 Protection of Transactions

In any e-business Weill and Vitale [10, pp.315-317] argue that the important question is "Who owns the transaction?" Organisations owning the customer transaction are able to set a fee or collect a profit margin for the service provided. The service could be for the sale of products, the provision of information or advice, or the provision of a professional service. Therefore, owning the customer transaction has the potential to generate customer revenue for the service. Owning the transaction also implies that the organisation owns the customer data related to those transactions. However, perhaps no other customer data will be owned unless the organisation also

owns the customer relationship. Owning the customer relationship provides influence where the customer looks to the relationship holder for trust, recommendations, and specialist advice.

The strength of the relationship with the customer will often determine the success of the business. The relationship will be determined by the strength the value of the service to the customer and the ability to deliver. This strength of will involve the brand, the breadth of offerings, the price-value equation, and the completeness of the consolidation into a single point of contact. Information is the lifeblood of e-business. The viability of many businesses will depend on access to information about customers' products, markets, and costs. The organisations ability to identify, capture, share, and exploit the key information strongly influences business profitability [10, pp.259-261].

Content providers are organisations that create and provide information products or services in digital form to be used by customers via third parties. In general the content provider owns none of the end-customer relationship, transaction, or data. Therefore, to be successful the content provider must be highly desirable and in demand as a supplier of content. Furthermore, not owning any of the customer assets - relationship, data, or transaction - makes the content provider very reliant on third parties. On the other hand, content providers typically have a relatively small number of direct customers, and therefore they do not incur the costs of managing relationships with a large number of customers [10, pp.253-256].

### 3.3 Potential difficulties

Many traditional and profitable businesses are challenged by the need to respond to the threats and opportunities of e-business.

Most large traditional firms are successful and profitable, and they achieved their success via strong leadership and cultures suited to their industry. Weill and Vitale [10, p.13] argue that these leaders are often poorly prepared to make major strategic commitments necessary for e-business, and are reluctant to take the initiative, preferring to wait and see. This attitude actively works against new initiatives that threaten the status quo. The challenge is that senior management must actively work to shape the e-business vision, their employees, and the organisational culture into a new model for the way business is undertaken.

Channel conflict is a real risk with e-business. The Internet offers a new channel to the customer, and businesses can choose to bypass existing channel partners, leading to channel conflict. Particularly difficult to handle is channel conflict where the customer is offered very similar value propositions directly, and alternatively by an intermediary, but at different prices. Steps to help avoid channel conflict include [10, pp. 306-307]:

- Segment the channels by customer by targeting the customers for online selling.

- Segment the channels by product by distributing some products online, and other products via traditional channels.
- Refine the dealers' role by defining the role of the retailer as one of display, test-drive, and configure the product or service.
- Develop a new brand or re-badge the existing product to sell directly, giving these items a different value proposition to the products sold by the retailers.
- Establish an information Web site with product description, and perhaps a virtual community, and pass all leads to the retail channel (the distributors).
- Retreat from selling similar products, and avoid an un-winnable price war.

Weill and Vitale [10, p.15] also argue that infrastructure requirements for e-business are stretching the capabilities of many organisations' IT portfolios. Traditional organisations are struggling with B2B e-business implementations that may require integrating their recently installed and expensive enterprise resource planning systems (ERPs) with their Web sites and the Web sites of partner firms. Also, one of the major challenges for the direct-to-customer organisation selling a physical product is getting the right product to the right address, reliably and economically. Many innovative businesses have developed attractive Web sites, but have not developed a clear understanding of the complex logistics involved in e-business. In response, some logistics companies see delivery of goods ordered via e-business as an opportunity to expand their influence (FedEx).

The use of multiple business models across an organisation can cause confusion for customers, especially if the customer needs to adopt a variety of different business practices within the organisation. Where various business units within the organisation use different models, confusion can arise if the customer is treated as a different entity by each business unit. Furthermore, implementing more than one model can lead to the further problems described above, including channel conflict, competency conflict, infrastructure conflict, and information conflict [10, p.82].

### 3.4 Threats from e-business

Organisations must also consider the specific threats that e-business make to the continued successful conduct of business. A number of questions should be addressed.

How large is the potential for competitors to undermine the loyalty of the organisation's customers? Weill and Vitale [10, p.294] observe that loyalty has two important components - brand identification, and switching costs. If customers have high brand identification, based on lifestyles and other personal traits, they will be more loyal. If the switching cost for a

customer to change brands is high, then they will also be more loyal.

How large is the gap between the current and the potential customer self-service?

Customer self-service is defined as providing an attractive value alternative to customers who can serve themselves. An important question asked by Weill and Vitale [10, pp.294-295] is: "How much does your customer dislike dealing with your organisation in person."

What is the difference between your organisations current geographical reach and its potential reach with the Internet? Weill and Vitale [10, p.295] observe that the larger the gap, the greater the threat or opportunity from e-business. However, many organisations' geographical reach is limited by external constraints, including other countries' regulations, tariffs and the cost of transportation.

## 4. Case Study - Razoredge Limited

The following is a case study that is based upon a real world organisation - RazorEdge Limited. It illustrates a particular project approach to e-business development with attention to risk management issues.

The case is of an Australian buying group for retail business with the following profile:

- 700 Members (independent retailers) located throughout Australia.
- 500 Suppliers (manufacturers and/or importers).
- Au\$150 Million annual turnover.
- Gross profit margin is 2.5 - 3.5% (very lean!!!).
- 55 Suppliers use electronic data interchange (EDI)
- These suppliers contribute 65% to 75% of business.
- 70% of members have access to a computer.
- Employs about 40 staff in two groups - Marketing, and Finance and Management.

The major challenge faced by RazorEdge Limited is the fear that suppliers or others will use technology to exclude the company from the loop. Also, business models are changing, as are relationships due to technology. Specifically RazorEdge Limited seeks to achieve the following objectives:

- Greater efficiencies and reduction in costs.
- Better communication with our members, suppliers, and the wider industry.
- Form alliances with key suppliers without risking loss of business, especially direct trading between suppliers and members.
- Increase revenue through special products, supplier links, and bulk order taking.
- The new bottom line - "Branding" is essential - RazorEdge Limited - the business and the brand must be leaders in the market, both "real" and "electronic".

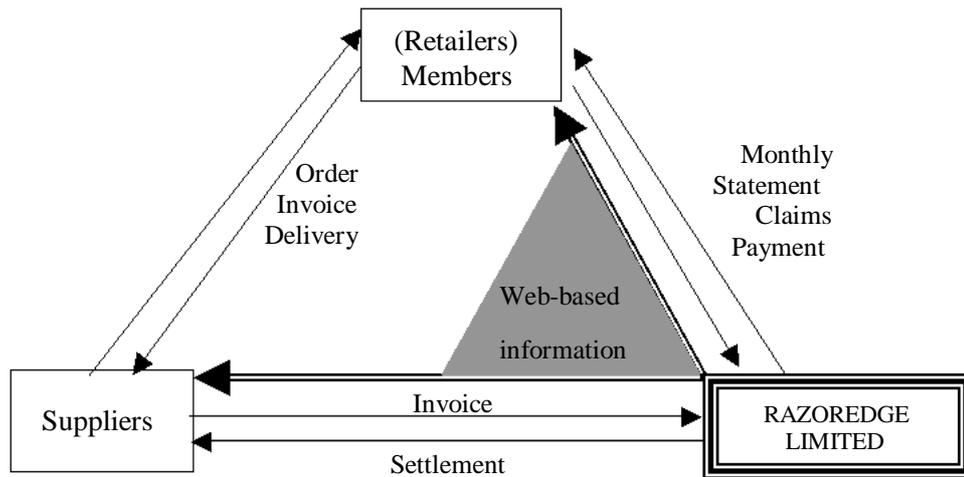


Figure 1 - RazorEdge Limited current business model

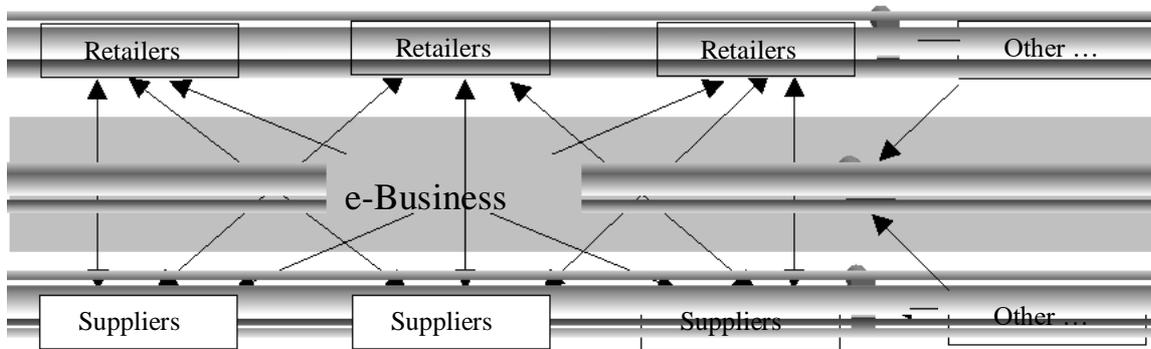


Figure 2 - Model of the Electronic Market  
(Adapted from Baron, Shaw, and Bailey, [1, p.94] & Weill and Vitale, [10, p.186])

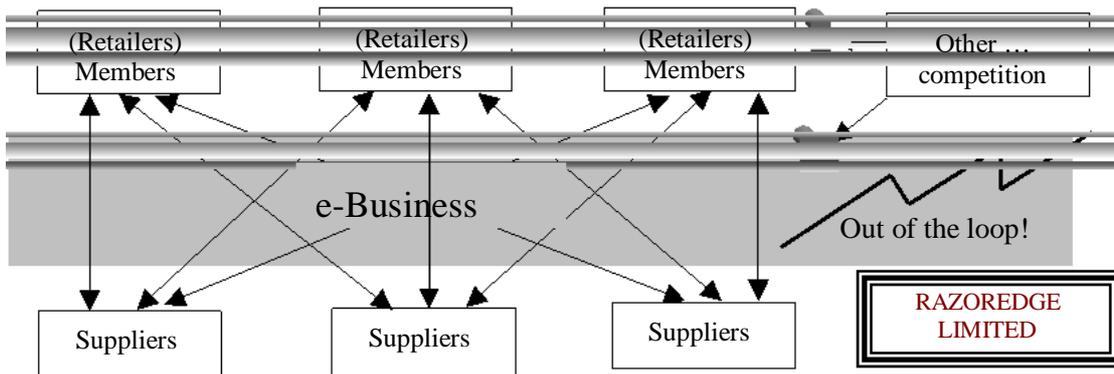
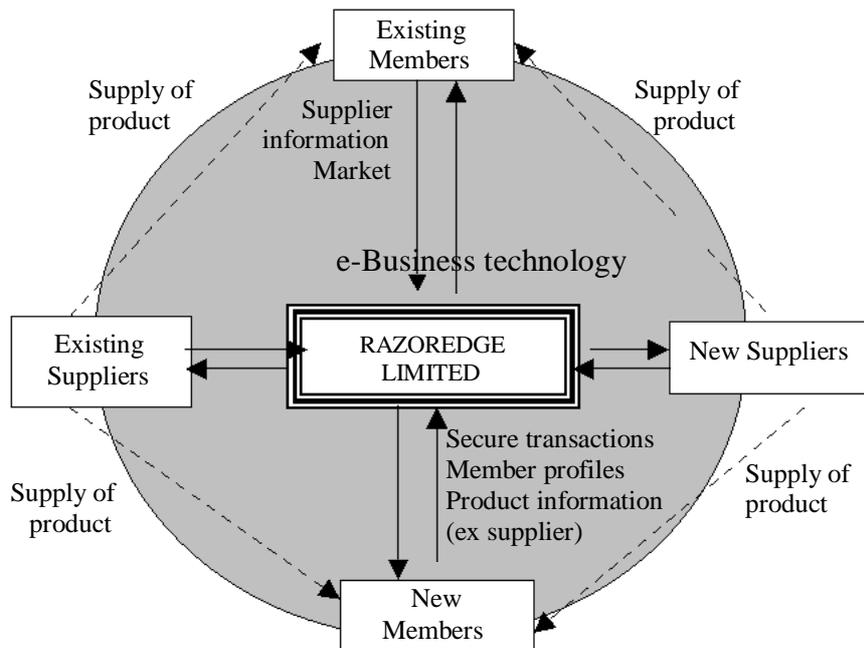


Figure 3 - The threat of the Electronic Market

The above model (Figure 1) represents RazorEdge Limited's current operations. It illustrates the major relationships that the company has maintained to achieve its business goals.

In evaluating the risk faced by RazorEdge Limited, the model of the electronic market (Figure 2) is an important consideration. This model has information technology

serving as a key component in creating the market. Individual firms operate within the electronic market using technology as an intermediary to interact with end customers. It allows firms to compete in an open market, while allowing customers to select from a variety of potential suppliers.



**Figure 4 - Suggested model for RazorEdge Limited**

As can be seen in the model in Figure 3, the Electronic Market is a potential threat to the continued operations of RazorEdge Limited. Therefore Figure 4 is a suggested model for RazorEdge Limited to minimise risk while achieving the key objectives.

In planning an implementation strategy based upon this model, RazorEdge Limited took into account that the e-business environment is characterised by rapid change in two critical areas:

- Information technology, the Web, and associated applications are constantly being developed and improved.
- The “users” understanding of their needs and the potential of e-business is also subject to growth. This can lead to considerable change in the system requirements.

Therefore traditional system implementation approaches are not ideal in this situation. Rather, it is recommended that prioritised initiatives be undertaken in a series of “short time-boxes” – one month duration – development cycles. This is an approach that has been developed for object-oriented systems development, which is closely aligned with e-business [4, pp.21-22]. These short development cycles, and the opportunity for frequent replanning are the critical elements for success. The suggested process is as follows:

- Identify the initiatives to be undertaken, and using these set priorities. The initiatives with the highest priority will be the first to be undertaken. Generally speaking, this will include review of the extendibility of the system architecture, as this will provide a component of the framework for future development.
- Plan the “project activities” for the next two months. Need to consider:

- Which knowledge elements to start with?
- What to develop first?
- What platforms to use?
- What roles and policy to establish?
- Regularly – 3 monthly or sooner if needed – review the initiatives and reset the priorities as required by the “current reality”.

Applying this to the RazorEdge Limited case, the following prioritised initiatives were established:

1. Product information - must be accurate, relevant and up-to-date.
2. Company information - including member profiles and supplier details.
3. Push information – trial intelligent agents to push product to market.
4. Develop membership community - with the focus on RazorEdge Limited.
5. Develop communication and negotiation support.
6. Information management - details of member history, delivery of orders, and claims.
7. Transactions capture – collecting details of transactions at line-item level.

The first three initiatives were successfully undertaken and implemented. The project was then reviewed and subsequent priorities replanned to accommodate the changing business conditions.

## 5. Conclusion

Before committing an organisation to an e-business project the following risk-oriented questions should be examined.

1. What is the combination (if any) of e-business models? This should also consider the sources of revenue, and whether they are realistic.
2. What customer segments are targeted, and what is the value proposition to each customer segments?
3. Who owns the relationship, data, and transactions, and what is the likely intimacy of the customer relationship? There is also a need to identify what are the channels to the customers and are they capable of supporting the required richness of information provision and capture?
4. What are the critical success factors, core competencies, IT infrastructure capability and the key information necessary to succeed?
5. What conflicts are inherent in the e-business initiatives?

## References

- [1] Baron, J.P., Shaw, M.J. & Bailey, A.D. Jr. "Web-based E-catalog Systems in B2B Procurement," *Communications of the ACM*. 2000, 43 (5), 93-100.
- [2] Becker, T. "Rating the impact of new technologies on democracy," *Communications of the ACM*. 2001, 44 (1), 39-43.
- [3] Greenstein, M. & Feinman, T.M. *Electronic Commerce: Security, Risk Management and Control*. Irwin McGraw Hill, 2000.
- [4] Larman, C. *Applying UML and Patterns: An Introduction to Object-Oriented Analysis and Design*. Prentice Hall PTR, 1998.
- [5] Lewis, T. "Innovation equals risk reduction," *Computer*. 2000, 23 (10), 112.
- [6] Netscape, *SSL 3.0 Specification*. 2002, <http://www.netscape.com/eng/ssl3/> (Accessed on 15 May 2002).
- [7] Schneider, G.P. & Perry, J.T. *Electronic Commerce*. (2<sup>nd</sup> ed.) Course Technology - Thomson Learning, 2001.
- [8] Schwalbe, K. (2002) *Information Technology Project Management*. (2<sup>nd</sup> ed.) Course Technology - Thomson Learning, 2002.
- [9] SET Secure Transactions LLC, SET Secure Transactions LLC Home. 2002, <http://www.setco.org/> (Accessed on 15 May 2002).
- [10] Weill, P. & Vitale, M.R. *Place to Space: Migrating to eBusiness Models*. Harvard Business School Press, 2001.

# Implications of Virtual Interviews as a Global Recruitment Tool

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## Abstract

Global business environments have become increasingly competitive. Consequently, businesses are seeking newer methods to improve efficiency, reduce costs, market new products faster, and retain customers for the long haul. One of the methods that has emerged to aid businesses accomplish all these goals is computer-mediated communication (CMC) applications. Computer-mediated communication applications in employment interviewing have received some attention from businesses since the emergence of the Internet. Existing technology makes it feasible for employers to screen and interview prospective employees without these applicants leaving their homes globally. Current trends suggest that electronic recruiting will constitute a significant portion of human resource management activity in the future. This paper discusses (1) the employment interview and its role in virtual recruiting, (2) virtual interviewing within the framework of computer-mediated communication (CMC), (3) organizational applications of virtual recruiting systems, (4) virtual organizational communication and how its attributes lend themselves to implementing virtual interviewing in organizations, (5) the relationship between virtual organizational communication and virtual recruitment, (6) Internet-based interviewing in the context of transaction economics, (7) whether or not virtual interviews will replace traditional interviews, and (8) managerial implications of virtual recruitment and interviewing in organizations. This paper concludes by proposing areas for further research.

## 1. Introduction

Global business environments have become increasingly competitive. Consequently, businesses are seeking newer methods to improve efficiency, reduce costs, market new products faster, and retain customers for the long haul. One of the methods that has emerged to aid businesses accomplish all these goals is technology-based applications such as computer-mediated communication (CMC), multimedia, and the Internet, among many other indications.

The dynamic business environment in which companies operate also requires efficient allocation of resources among the various functions that a company must perform to remain competitive. Therefore, companies must decide which of their core functions they need to maintain in-house, and which ones they need to outsource. As fast-growing start-up companies or even the well-established ones engage in the task of episodic recruiting to meet their expansion goals or simply to fill vacancies due to staff turnover, some have turned to "virtual recruitment" [25] as a means of curtailing recruitment expenditures of their human resource departments.

Virtual recruitment allows companies to outsource the search and selection of quality candidates without having to hire more permanent human resource staff, or increase spending for one of a company's non-core activities, the employee recruitment process. According to the International Association of Corporate and Professional Recruitment (IACPR), it takes, on the average, about 4.13 months, to find and recruit suitable candidates [20]. Many companies are now using virtual recruitment as a viable means for recruiting workers.

The concept of a "virtual organization," where a company completely or partially outsources one of its non-core activities, is not novel. Over the past few years, the concept of outsourcing has received mixed reviews from the business world in terms of its effectiveness [25, p. 853]. The information technology (IT) industry has embraced the idea; so has the Human Resource Management (HRM) industry. Many companies are now reducing their non-core business activities such as employee recruitment and outsourcing such functions to consulting firms. Functions typically outsourced in the IT industry tend to focus on internal support services, such as management of servers and desktop computer support. Other industries such as the pharmaceutical industry also contract with external consulting firms to carry out large-scale clinical trials on products without having to maintain a complete department that would not be used for long stretches of time once a particular clinical trial is completed. Similarly, in the sales environment, industries are increasingly relying on outsourcing.

Companies outsource their employee recruitment function at varying degrees from a simple company-consultant relationship to business partnership agreements with shared goals. Regardless of the business relationship, outsourcing can offer a commercially viable alternative to setting up and maintaining departments that may not be used constantly, an option which is particularly attractive to companies faced with massive budget cuts. A company's employee recruitment function is a prime example of how virtual recruiting can be beneficial to the company. Recruitment for most companies comes in waves. A company may wish to insulate itself against an eventual lull in recruitment activity and the necessity to lay off human resource staff by engaging in virtual recruitment.

Given the growing interest in virtual organizations in management literature, there is a preponderance of research on the possibilities of virtual meetings, work teams, offices, factories, firms, and alliances. However, little empirical research exists on virtual organizations [12], and surprisingly, very little has been done on virtual recruitment. This paper is an initial attempt at setting an agenda for possible sustained research on the impact of technology-based systems such as virtual recruitment systems on employment interviews. This paper discusses (1) the employment interview and its role in virtual recruiting, (2) virtual interviewing within the framework of computer-mediated communication (CMC), (3) organizational applications of virtual recruiting systems, (4) virtual organizational communication and how its attributes lend themselves to implementing virtual interviewing in organizations, (5) the relationship between virtual organizational communication and virtual recruitment, (6) Internet-based interviewing in the context of transaction economics, (7) whether or not virtual interviews will replace traditional interviews, and (8) managerial implications of virtual recruitment and interviewing in organizations. This paper concludes by proposing areas for further research.

## **2. The Employment Interview and Virtual Recruiting**

The employment interview is an interactive process in which the prospective employer and the applicant assess and select each other. Organizations typically use the interview to recruit and select employees. Even though extensive research exists concerning the selection of applicants, recent changes in competitive markets have made the ability to attract and retain the very best employees more critical to organizational success. Organizations are constantly looking for the most efficient and cost-effective means of conducting employment interviews. Given recent advances in computer-mediated communications (CMC), especially the pervasiveness of technological advances such as multimedia and the Internet, personnel recruitment vendors are busy

developing new virtual (electronic) recruiting systems to enable both companies and applicants participate in the employment screening and selection process quickly and in the most cost-effective manner. Recruiters can also conduct global recruitment using technology-based solutions.

Of particular significance to using virtual recruitment systems to select candidates is the risk which traveling to distant locations has now imposed on recruiters and applicants given the current climate of global terrorism, exacerbated by the September 11, 2001, attacks in both New York City and Washington, D.C.

Other issues which have motivated companies to consider using technology-based recruitment systems, in addition to the simple objective of selecting the best candidate who has a great "fit" with the organization, have become paramount. These issues include the proximity of the applicant to the recruiter (the location of the applicant and the recruiter which attenuates the specter of potential terrorist attacks against the applicant and the corporate recruiter), the most appropriate channel to use in conducting the interview (written, interpersonal, or virtual), and which medium affords the participants the best opportunity to evaluate each other.

Employment interviewing and recruiting is an expensive, high-stakes game. Even for relatively unskilled employees search costs can amount to several thousand dollars. The U.S. Department of Labor estimates that it costs a company one-third of a new hire's annual salary to replace the previous individual [37], while other sources propose figures in the range of 1.5 to 2.5 times annual salary [7]. Moreover, unsuitable employees waste valuable firm resources, including compensation, training, and supervisory effort. Simple, comprehensive, and effective methods of identifying and screening potential employees are an attractive tool for employers.

Technology-based recruitment applications have received significant attention from businesses since the emergence of the Internet. Existing technology makes it feasible for employers to screen and interview prospective employees in geographically dispersed locations nationwide and globally. Current trends suggest that virtual recruiting will constitute a significant portion of human resource management activity in the future.

One of the major activities involved in recruiting high-caliber employees is the employment interview. Employment interviews fall under the rubric of interpersonal communication which will be impacted by the all the elements of the communication process: sender, receiver, message, channel/medium, feedback, and environment. While trade publications, college Web sites abound with information about virtual recruiting, very little research-based studies exist which explain the extent to which technology-based systems will impact employment interviews conducted in a "virtual" or electronic environment.

### **3. Computer-Mediated Communication and Virtual Interviews**

Computer-mediated communication (CMC) systems have now become an integral part of society, since they span education, industry, and government. In order to appreciate fully the impact of CMC on various organizational processes, it is necessary to define the term, since CMC means different things to different people.

Computer-mediated communication (CMC) refers to both task-oriented and interpersonal communication systems conducted using computer. This includes asynchronous communication (via e-mail or electronic bulleting boards); and synchronous communication ("chatting" or group software); and information manipulation, retrieval and storage through computers and electronic databases [17]. CMC is a process of human communication via computers, involving people, situated in particular contexts, engaging in processes to shape media for a variety of purposes [10]. Other researchers have attempted to reconcile the various attempts at defining CMC by offering this perspective--CMC comes in increasing number of forms; the technologies for mediating CMC are changing rapidly; diversity of users and uses is increasing; and many forms of CMC, particularly where interpersonal communication is concerned, seem to explicitly or implicitly serve multiple purposes. For instance, Murray presents an approach to CMC which treats CMC as a form of communication that is socially constructed, is subject to multiple research methods, and renders any attempt at overt generalization meaningless [27].

Virtual interviewing (VI) is an umbrella term which refers to a variety of computer-mediated communication (CMC) tools used to screen, recruit, and hire employees in geographically dispersed locations. Whereas electronic mail has been a frequent subject area for previous communication research, the global Internet today offers a more diverse set of tools and contexts for communication than it has in the past.

The drive to improve efficiency has given rise to an elevated interest in technology management ranging from ownership to use of new technologies. While many technologies tend to be of primary interest to one or two industries, almost all industries have an interest in information technology (IT). Most companies today cannot function without a computer system. These have been employed in all business areas, from education to manufacturing to construction. Management personnel are realizing that their competitive edge may hinge on the ability of their computer and communication systems to respond quickly to changing business needs. Consequently, business has to stay abreast of competitive moves in the use of CMCS and in many cases, be prepared to stay ahead of the competition [19].

A growing consensus amongst scholars, politicians, business leaders and the news media is that technologies traditionally referred to as new media are indispensable to the sum activities now referred to as electronic-commerce (e-commerce) and business-to-business (B2B) [32]. New media incorporates what is commonly known as multimedia. The term multimedia generally refers to the convergence of images, graphics, sound, voice, videotext and tubular information within a human interface that uses capabilities to access and present information. The primary marketing advantage of CMCS these days is the inclusion of multimedia facilities [21]. Such facilities may be used for videoconferencing, personnel training, as well as an interactive mechanism between management and employees or potential employees.

In contrast to long-distance telephone interviews, videoconferencing enables the candidate and the interviewer to see each other on screen. Moreover, better cameras and clearer links have improved videoconferencing in recent years. Even employers who prefer the traditional face-to-face interview concede that video technology is useful for weeding out undesirable job candidates. The employer is able to study the interviews in close detail and can replay parts of the interview to assess reaction or response—something not possible in a conventional interview. The next section discusses some applications of virtual recruiting systems which various organizations are now using to satisfy their employee recruitment needs.

### **4. Organizational Applications of Virtual Interviewing Systems**

Technology is changing how companies recruit and select applicants [36]. Even though virtual hiring technologies are still in their infancy, current virtual hiring technological advances have the potential to enable recruiters to reduce hiring cycle times by 90 percent, anticipate what skills will be in demand before they can be articulated, and call up information about a potential candidate on their computer screens.

The growth in the use of CMC during the last decade surpassed even the most optimistic predictions [13]. The pervasiveness of CMC has spurred intense competition among companies that produce "virtual" (electronic) employee recruitment solutions. These solutions vary in terms of their delivery modes and across a wide range of industries, companies, and applications.

One form of CMC content delivery is videoconferencing via the video. Its effectiveness has been well documented elsewhere [4] [9]. Videoconferencing enables geographically dispersed parties to communicate with each other in real time, and asynchronous video presentations enable participants to access the contents of the video from anywhere, and at any time [35]. Videoconferencing can slash recruiting travel expenditures by 20 percent [20, p. 87]. With enhancements in video quality (30 frames per second, on par with television), some companies are now making videoconferencing a part of their recruitment arsenal.

Best International, a computer recruiting company, regularly uses videoconferencing to conduct employment interviews overseas. The technology not only eliminates the cost of overseas travel but expands the firm's recruitment base and saves time in screening job candidates. These days, thousands of companies like Best are turning to technology as a recruitment tool. Businesses are conducting virtual interviews from remote locations by establishing videoconference links around the world. Some companies videotape interviews of overseas job candidates, transfer the tapes to CD-ROM, then view the interviews at their convenience. Others use electronic file transfers, downloading interviews as e-mail files; and computer experts predict that conducting interviews via real time Internet video chats will become commonplace in the near future.

AT&T, Dell Computers, Shell Oil, Compaq Computer, and Nike are using videoconferencing to screen and select candidates. Other companies are using in-house systems which cost anywhere from \$10,000 to \$35,000, to screen candidates around the country. Management Recruiters International (MRI) in Cleveland, Ohio, uses a videoconferencing system called ConferView, to screen job applicants in 380 MRI offices. Hire Intelligence, a web-based recruiting firm in Houston, Texas, provides a service which allows recruiters to videotape interviews to a website. Corporations log on to this site ([www.hiirs.com](http://www.hiirs.com)) and check out candidates for free [36]. Kinko's rents videoconferencing rooms at a quarter of its 900 stores for about \$150 per hour; National Career Center in Boulder, Colorado, offers similar services in a more intimate setting through its SearchLINC videoconferencing system. This system is available through deals with major hotel chains such as Radisson and Hilton, and is expected to increase in the next few years.

Another form of CMCS is Interactive Voice Response technology (IVR), which has been used for a long time, is now being integrated with other database technologies to capture information about potential employees, giving the company more flexibility and speeding up hiring decisions [36, p. 73]. Some companies have used is computer-assisted interviewing online to find the right hires.

Nike has used an AspenTree IVR technology product to hire employees for Niketowns, retail stores that showcase Nike products [36, p. 75]. The computer interview (which includes a video showing three scenarios for helping a customer and asks the applicant to choose the best one) is conducted in batches. A group of applicants is given 45 minutes to respond to the scenarios. As applicants complete their interviews, a printer in another room prints their responses. Areas that need to be probed further are flagged including indications of applicants' particular strengths. While applicants complete a virtual interview, the recruiter uses the applicant's printout to prepare for face-to-face, human interview. Since Nike uses behavior-based interviewing, virtual interviewing not only helps Nike's interviewers screen for applicants who lost their temper in work situations or who demonstrated other undesirable behaviors, it also helps interviewers to determine what to ask to reconcile inconsistencies in the virtual interviews or to probe applicant strengths in desired areas.

Coopers & Lybrand, one of the first companies to put its computer-assisted interviewing system on the Internet, also uses an Aspen Tree product. The company uses a website called Springboard. Applicants complete an employment application and four initial screening modules at their convenience by accessing the website and the Strategic Selection Advantage (SSA) Online application. The company has found a high correlation between high job performance ratings and superior performance in the SSA Online application. By taking the technology to the Internet, a company can reach prospective employers.

Innovex, Inc., a division of Quintiles Transnational Corp., a contract pharmaceutical company produces late-phase clinical studies to long-term marketing partnerships with pharmaceutical companies, uses an IVR product developed by TelServ of Cleveland, Ohio. Innovex uses IVR primarily to eliminate much of the labor of having people sift through large volumes of resumes. Applicants who respond to job advertisements call a toll-free number. They are asked a series of questions by a machine and those who meet the basic criteria are then referred to Innovex for face-to-face interviews.

Olsten also uses IVR technology developed by Wonderlic of Libertyville, Illinois, to prescreen applicants. According to Adrienne Plotch, vice president of professional service, IVR has saved the company significant staff time, and is accessible by applicants any time.

In spite of their widespread use, recruitment experts acknowledge that CMC systems use will increase, but it will not replace the personal interviews. Final interviews will always be face-to-face, in person.

## **5. Relationship Between Virtual Organizational Communication and Virtual Recruitment**

A virtual organization has been described as a collection of geographically distributed, functionally and/or culturally diverse entities that are linked by electronic forms of communication and rely on lateral, dynamic relationships for coordination [12]. The components that make up a virtual organization are geographically distributed, functionally or culturally diverse, electronically linked, and connected via lateral relationships. These attributes enable the organization to dynamically modify business processes to meet market demands, to coordinate via formal and informal contracts, to define the boundaries of the firm differently over time or for different customers or constituencies, and to re-arrange relationships among components as needed. These attributes lend themselves well to virtual recruitment whereby some organizations establish relationships at different levels to enable them carry out certain non-core organizational functions such as employee screening and recruitment.

Few pure virtual forms exist today [14]. Instead, aspects of virtuality occur in many business enterprises. For example, although most companies still maintain a divisional structure, they increasingly are forming external relationships with other firms in the form of strategic partnerships, alliances, and outsourcing contracts [26] [28]. In addition, rapid advancements in telecommunication technologies have enabled more telecommuting and cooperation among physically distributed employees [2]. These trends suggest that firms are acquiring more virtual characteristics than in the past. Even firms that may not look virtual on the surface are organizing selected activities and processes, such as employee recruitment virtually.

Communication is fundamental to any form of organizing, but it is preeminent in virtual organizations. Without communication, the boundary-spanning among virtual entities would not be possible.

Virtual (electronic) communication enables parties to link across distance, time, culture, departments, and organizations, thereby creating "anyone/anytime/anyplace" alternatives to the traditional same-time, same-place, functionally-centered, in-house forms of organizational experience [30]. Virtual communication loosens constraints of proximity and structure on communication, making it possible for spatially or organizationally distant parties to exchange messages with one another [16]. Further, virtual communication provides an opportunity to signal interest in forming connections that otherwise would be difficult or impossible to maintain [18].

The exact nature of communication processes in virtual forms, their antecedents and consequences are, of course, unknown as of yet. However, it is possible to glean some insight from the rich body of literature on synchronous and asynchronous electronic organizational communication. Employee recruitment will certainly continue to become more electronically mediated than in the past, and the vast set of empirical findings regarding mediated communication can foreshadow how employee recruitment will change as firms "go virtual" with their employee recruitment needs.

## **6. Internet-based Interviewing and Transaction Costs**

The strategic use of Human Resource Management (HRM) to enhance organizational performance has been examined in the literature. This approach "suggests that HR (both the function and the system) contributes directly to the implementation of the operating and strategic objectives of firms" [3]. The fact that progressive human resource practices which affect employee skills, motivation, and work design are associated with improved organizational performance, and an important component of those systems is "sophisticated selection procedures designed to screen out all but the very best potential employee" has been documented in empirical studies [11].

Although different conceptual models can be advanced to explain the links between HRM and organizational performance, transaction cost theory provides a particularly useful framework of analysis of the implications of new technologies in hiring employees. A fairly important issue of transaction cost economics is concerned with the nature of economic organizations as distinct from labor market exchanges. Therefore, transaction cost theory suggests that electronic recruiting could quite conceivably become the technological watershed of employment relations. This is because when viewed from a perspective of competitive advantage, Internet hiring for instance, will most certainly affect organizational strategies to maximize the value of limited labor resources [23].

According to transaction cost economics, organizations hire workers when the cost of purchasing labor on the open market surpasses the cost of long-term, relational contracting. At the core of this doctrine summarized is that "transaction cost economics is an effort to identify, explicate, and mitigate contractual hazards. In general, all hazards can be attributed to the twin behavioral assumptions from which transaction cost economics works: bounded rationality and opportunism" [38]. One can conclude from the behavioral assumptions, that an employment contract is necessitated when contingencies cannot be fully addressed through ex ante agreement.

Neither employers nor employees possess sufficient information to identify and negotiate over critical issues arising out of the labor purchase; thus, an independent contractor or market relationship is unacceptable to the parties [22]. Both employees and employers will strive to gain economic advantage from the relationship because of opportunism and the need to protect self-interest.

Two other characteristics that affect employment are: "fundamental transformation," and "asset specificity" [38]. In "fundamental transformations," even though the employment process starts out with large numbers bidding at the commencement of contracting, what happens later is ongoing dealings between parties. In "asset specificity," owners and workers come to a position of bilateral dependency through acquisition of firm-connected skills, unique technologies, and other idiosyncratic factors [38]. Because the costs of market transactions under such circumstances may be high, relational contracting through employment and its governance procedures minimizes contracting hazards [23]. Also, researchers have noted that internal corporate hierarchies and lavish upper management incentives inoculate organizations against hiring errors by restricting access to entry-level positions. Hence, opportunists are less likely to exploit firms by seeking lateral transfers. The preceding ideas are relevant to this analysis of the implications of virtual interviews as a global recruitment tool.

First, virtual interviews (VIs) expand the prospect of global recruiting. There are no effective geographical restrictions on the technology used for VIs. The potential reach for VIs offers the most expansive applicant pool with almost real time communication between buyers and sellers reminiscent of the large numbers bidding scenario that has been referred to as "fundamental transformations" [38]. The sheer size of the applicant pool that can be achieved using VIs guarantees organizations access to a wide pool of prospective applicants and quite likely, the most qualified. Invariably, competition for labor will subsequently generate repeat recruiting using VIs.

Secondly, the large number of potential applicants that VIs can attract calls for efficient methods of screening. VI is an efficient mechanism for rapidly eliminating unsuitable candidates thereby reflecting Williamson's earlier take on "fundamental transformation." Naturally, some problems cannot be fully eliminated. There is no foolproof way of ascertaining the truthfulness or accuracy of information on an audio tape or video tape, however, similar issues are encountered in traditional interviewing methods as well [24].

A third and final reference to transaction cost economics sheds more light on the relevance of employment trends. As Williamson points out, if markets could perform the "experience-rating functions," the need for entry level hiring and job progression would be mute. Recent research has documented apparent shifts in employment from job security and internal labor markets to flex work environments, virtual offices and outside contracting. These trends are driven by powerful forces undermining traditional employment practices [6]. To show how these trends are progressing with respect to white-collar employment, three factors driving the "transformation of managerial work" have been identified [31]. These factors are competitive pressures to reduce labor costs, new information technology, and the new ways of organizing work. A plausible implication is that these changes will likely affect the nature of managerial tasks and influence career patterns as ladders become shorter, the organization becomes flatter, and boundaries of all kinds become permeable.

Other researchers predict similar developments in work of all types. At the dawn of a new era in organizations, the boundaryless career has emerged as one of the new principles of employment. Some experts have even predicted the "end of the job" as employers shift toward contingent, short-term contracting [1] [5]. Others foresee a technological revolution which will generate massive upheavals in labor markets [33]. At the very least, job trends will probably result in a break with traditional approaches to HR functions [22]. One can reasonably conclude that organizations will become more sophisticated in acquiring and analyzing information about individuals and less reliant on long-term observation of work performance in evaluating employees. Technology will obviously play a prominent role in these changes.

It is clear then, that employers have reasonable motivation to use electronic technology for purposes of conducting job searches and recruiting qualified applicants. Although external factors create incentives for organizations to develop and implement strategic information systems, legal considerations may impose some constraints on the electronic job market.

## 6.1 A Basic Distinction

For practical reasons, a basic distinction about the possible tools for virtual interviews will be assumed. We will distinguish between real-time communication tools, such as Internet Relay Chat (IRC) and the forms of interpersonal communication allowed by Multi User Dimension, Object Oriented (MOO) and Multi-user Domains (MUDs) on one side; and delayed communication tools such as email, on the other. Real-time communication tools allow interactivity, the exchange of an immediate two-way flow of information. Delayed ones do not. This has certain implications for their performance.

IRC, MOOs and MUDs allow people to meet and interact. IRC is aimed at providing chat, enabling its users to literally talk to each other, in the sense that questions and answers actually follow each other. MOOs and MUDs are virtual environments where people can interact, based on Telnet.

The shortcomings of real-time communication tools are related to their interactivity. What we are used to, as real-time talk, is immediate question and answer. That is possible only partially on IRC, for instance. There still is a considerable delay between the subsequent messages, which sometimes makes the communication quite strange: you might ask a question and get an answer which was intended for the previous question. One has to type his/her message and submit it quickly, so it is not 100 % interactivity. However, the development is very fast and we are getting closer and closer to "true" real-time.

## 6.2 Interviewing via E-mail

The alternative to the previous methods of virtual interviewing is email. With email, interviewers formulate their questions, mail them to interviewees, and patiently wait for an answer. An email user does not expect any interactivity. He/she will formulate the questions as clearly as possible, and very straightforwardly, to reduce the chances of misunderstanding. Moreover, the interviewee has all the time to answer the questions, can reflect about it, and thoroughly explain details. E-mail is great for research interviews, dealing with complicated or controversial matters. Encryption technology now allows users to protect their messages.

E-mail also has a few shortcomings. Among them is of course the time delay between the mail containing interview questions, and the mail from your interviewee with answers to those questions. Moreover, nothing guarantees that your mail will be answered promptly.

## 7. Will Virtual Interviews Replace Traditional Interviews?

Videoconferencing is not a substitute for a face-to-face interview, and a personal meeting would always be the first preference. But the advantages sometimes outweigh the disadvantages. This technology saves time, money and allows several locations to connect at once, in spite of major time differences.

We are all living in a world where technology is changing practically every instance. The place we go to work is also experiencing radical changes due to similar reasons. Every organization is trying its very best to capture market shares using cutting-edge customized solutions. This trend has also affected the way organizations are structured. Recent trends in organization structure suggest that they will become increasingly distributed, flexible and responsible to environment and market changes. The networked organizations emphasize on the multidisciplinary work arrangements linking people across organizational boundaries, less clearly defined authorities and multidirectional communication patterns [33].

The benefit of using diverse means for human resource practices cannot be overemphasized. The term multimedia has been coined to encompass a document or presentation that includes several delivery modes, and in practice, is used almost exclusively for computer-based material [34].

The appeal of network videoconferencing as a virtual interview tool for instance, derives from the breadth of interaction it offers; the user can see as well as hear the individual or members of the group at the other end. Even low-end videoconferencing systems offer interesting features such as document/application sharing and whiteboard tools that work across electronic conferencing links. These tools and applications make collaboration easy and reduce travel expenses.

Other factors contributing to the growing interest in videoconferencing include better compression techniques, maturing standards that encourage interoperability, high-speed LANs and WANs that support the data requirements of video, and high-performance multimedia computers. In addition, operating systems are multimedia enabled. Microsoft Windows includes a videoconferencing package called NetMeeting.

New uses for videoconferencing are also helping to drive development. In work environments, it is being used for tech support, distance learning, telemedicine, job recruiting interviews, direct sales, legal work, telecommuting, and manufacturing.

Employers can now see and judge appearance and body language to get a deeper sense of what applicants have to offer before flying them cross-country for interviews. This includes the capability of viewing applicants at multiple sites, in various states and countries, at the same time.

The potential for savings is obvious. Renting a videoconferencing room - the preferred option for companies who lack their own remote facilities --rarely costs more than a few hundred dollars per hour. Travel and hotel costs can easily exceed \$3,000 [15]. Arguably, a more important benefit is the expanded labor pool that videoconferencing lets an organization reach.

## **8. Managerial Implications of Virtual Interviews**

The possibilities offered by virtual recruiting are great when it concerns social relations. Organizations can reach a lot of people in geographically-dispersed locations and gather first-hand information from job candidates--that is, by conducting virtual interviews with people wherever they are in the world, and at a very cheap price. In spite of the widespread applications of virtual interviewing, several managerial implications are noteworthy.

First, there is no consensus among recruiters regarding the efficacy of virtual interviewing in recruitment decisions. Some argue that virtual interviewing makes it fairer for everybody, helps the interviewer choose the right people for the job, streamlines the hiring process, and allows the company to capture data that can be used later in hiring waves or in employee development and succession processes [36, p. 78]. Other recruiters are uncomfortable with virtual interviewing since they consider it a form of in-depth electronic profiling. They fear that electronic profiling will exclude people who do not fall within the desired response range, even though the applicant may have skills the company really needs. In fact, they contend that Bill Gates would never had been hired for computer work if profiling had been used [36, p. 78-79].

Critics of virtual interviewing also contend that human interviewers may pick up cues that virtual interviewing could not. By factoring in information the computer cannot anticipate, interviewers would be able to make better selection decisions. If profiling selects people who have the same personality traits, diversity, which can be a company's asset, may be lost.

Even though vendors of computer profiling products claim that the profiling done is often a safeguard against exclusion, some critics see computer profiling as a way for companies to exclude minorities [36, p. 79]. These vendors claim that they continuously test their data to ensure that questions do not automatically exclude any group.

Secondly, virtual interviewing is vulnerable to charges of discrimination under Title VII [23, p. 160]. Civil right laws prohibit employment practices which have a differential or disparate impact on specific groups. On one level, virtual recruiting can produce adverse impacts in the same way as any other procedure, such as a written test or an educational credential. A second and more problematic aspect of online recruiting, however, is that the technology itself may select against certain protected groups. That is, access to employment on the Internet arguably excludes racial minorities, women, and older workers in greater relative numbers than young, white males for example.

The National Telecommunications and Information Administration (NTIA) used Census Bureau data to develop a profile of Americans' telecommunications access [29]. NTIA found that the "information have-nots" are disproportionately located in rural areas and central cities. Broken down by race, data indicate that rural black households have the lowest computer ownership of any group (6.4%), followed by Hispanic (12%) and Native American (15.3%). Rural whites and Asians have the highest ownership, at 24.6% and 33.7%, respectively. Similar disparities appear in the central city populations. When minority households do have computers, they are less likely than whites to have an Internet modem connection.

The NTIA survey also showed further differences in access to computers and modems by age, income and gender. Individuals under 25 and over 55 are the least likely to own computers. Among those owning computers, those between the ages of 25 and 34 have greatest access to modems. Moreover, as education and income increase, so does the likelihood of owning the necessary technology for Internet use. In a separate study analyzing the Census Bureau data, the author found that women are slightly less likely to live in households with computers [8]. Invariably, certain groups appear to have unequal access to the Internet.

While virtual interviewing holds great promise as a viable recruitment tool, this technology-based tool is not yet ready to replace the traditional face-to-face mode of interviewing. Also, even if groups which feel disenfranchised by virtual interviewing cannot successfully challenge virtual interviewing as unfair employment practice, the possibility presents a realistic threat to global implementation of virtual recruitment processes.

## 9. Conclusion

This paper has attempted to show proliferation of options available to organizations when they choose virtual interviews as a recruitment tool. It is apparent that VIs can help HR practitioners to locate and attract qualified applicants in a competitive labor market. The paper has argued that Internet-based recruiting will grow. By expanding HR procedures to include the Internet, recruiters can benefit from an inexpensive, convenient, and innovative process to attract potential employees. Employers can minimize the risk of discrimination claims by supplementing electronic recruiting with more traditional sources.

Virtual interviews will inevitably play a prominent role in human resource management activities. The Internet for instance, has the potential to profoundly reshape employee recruitment and selection, and its promise as a strategic tool in organizational staffing goals appear immense. If organizations are cautious, HR professionals can realize the benefit of using computer technology to identify and select employees while maintaining a diverse workforce and avoiding legal complications.

A pervasive theme in this paper the focus on communication volume and efficiency. Compared to face-to-face communication, virtual communication appears to increase the overall amount of communication between or among communicating parties. There is no doubt that people perceive significant differences in communication channels, but the hierarchy of preference is not clear. For example, will recruiters prefer face-to-face and telephone over computer-based conversations? What salient factors do recruiters consider in choosing communication media?

Assuming communication volume goes up in virtual organizations, it is safe to assume that intense pressures for communication efficiency will also occur. However gains in communication efficiency for a given task, especially employee recruitment, may be difficult to achieve electronically. The literature strongly suggests that problem solving and task completion are not faster when electronically mediated. Achieving efficiencies that are needed in the dynamic process design of virtual organizations will continue to be a challenge, requiring more systematic research.

## References

- [ 1] Arthur, M. and D. Rousseau (eds.) *The Boundaryless Career: A New Employment Principle for a New Organizational Era*. New York: Oxford University Press, 1996.
- [ 2] Barner, R. "The New Millennium Workplace: Seven Changes That Will Challenge Managers And Workers." *The Futurist*, 30, 14-18, 1996.
- [ 3] Becker, B. and Gerhart, B. (1996). "The Impact of Human Resource Management on Organizational Performance: Progress and Prospects." *Academy of Management Journal*, 1996, 39: 779-801.
- [ 4] Bosco, J. "An Analysis of Evaluations of Interactive Video." Fifth International Conference on Computers and Education, Brussels, Belgium, 1990.
- [ 5] Bridges, W. *Job Shift: How to Prosper in a Workplace Without Jobs*. Reading, MA: Addison-Wesley, 1994.
- [ 6] Cappelli, P., Bassi, H. Katz, D. Knoke, P. Osterman, and M. Useem. *Change at Work*. New York: Oxford University Press, 1997.
- [ 7] Cascio, W. *Managing Human Resources: Productivity, Quality of Work Life, Profits*, 5th ed. Boston: Irwin McGraw-Hill, 1998.
- [ 8] Civille, R. "The Internet and the Poor." In B. Kahin and J. Keller (eds.) *Public Access to the Internet*, Cambridge, MA: MIT Press, 1995.
- [ 9] Cronin, M., and Cronin, K. "Recent Empirical Studies of The Pedagogical Effects of Interactive Video Instruction in "Soft Skill" Areas." *Journal of Computing in Higher Education*, 1992, 3(2), 53-85.
- [10] December, J. "Notes on Defining of Computer-Mediated Communication." *CMC Magazine*, Jan. 1997. Available Online: <http://december.com/cmc/mag/1997/jan/december.html>
- [11] Delaney, J. and M. Huselid. "The Impact of Human Resource Management Practices on Perceptions of Organizational Performance." *Academy of Management Journal*, 1996, 39: 949-969.
- [12] DeSanctis, G., and P. Monge. "Communication Processes for Virtual Organizations." *Journal of Computer Mediated Communication*, 1998, 3(4). Available Online: <http://asusc.org/jcmc/vol3/issue4/desanctis.html>
- [13] Dringus, L. "Connecting Resources in Online Learning Environments." *Online Journal of Distance Learning Administration*, 1999, II(II).
- [14] Dutton, W. "The Virtual Organization: Tele-Access in Business and Industry." In G. DeSanctis and J. Fulk (eds.), *Shaping Organizational Form: Communication, Connection, and Community*. Newbury Park, CA: Sage, 1999.
- [15] Essex, D. "Save Travel Costs and Expand your Worldwide Talent Pool by Interviewing Job Candidates Remotely." *IT World.com*, 26 Feb., 2001,.
- [16] Feldman, M. "Electronic Mail and Weak Ties in Organizations." *Office: Technology and People*, 1987, 3, 83-101.
- [17] Ferris, P. "What Is CMC? An Overview of Scholarly Definitions." *CMC Magazine*, Jan. 1997. Available Online: <http://december.com/cmc/mag/1997/jan/ferris.html>

- [18] Fulk, J., A. Flanagin, M. Kalman, P. Monge, and T. Ryan. "Connective and Communal Public Goods in Interactive Communication Systems." *Communication Theory*, 1996, 6, 60-87.
- [19] Gunasekaran, A. and P. Love. "Current and Future Directions of Multimedia Technology in Business." *International Journal of Information Management*, 1999, 19, 105-120.
- [20] Hanover, D. "Hiring Gets Cheaper and Faster." *Sales and Marketing Management*, Mar. 2002, 87.
- [21] Hill, S. "Lights, Camera, no Action." *Manufacturing Systems*, 1995, 13 (2), 6-7.
- [22] Hogler, R. "Transforming Employment Relationships: Implications for Human Resource Management." *Human Resource Management Review*, 1996, 6, 75-88.
- [23] Hogler, R., C. Henle, and C. Bemus. "Internet Recruiting and Employment Discrimination: A Legal Perspective." *Human Resource Management Review*, 1998, 8(2), 149-164.
- [24] Hubbart, W. *The New Battle Over Workplace Privacy*. New York: Amacom, 1998.
- [25] Mills, E. "Virtual Recruitment." *Nature Biotechnology*, Aug. 2002. Available Online: <http://biotech.nature.com>
- [26] Mowshowitz, A. "Virtual Organization: A Vision of Management in The Information Age." *The Information Society*, 1994, 10, 267-288.
- [27] Murray, D. "The Composing Process for Computer Conversation." *Written Communication*, 1991, 8, 35-55.
- [28] Nohria, N. and Berkley, J.D. "The Virtual Organization: Bureaucracy, Technology, and The Implosion of Control." In C. Heckscher and A. Donnelon (eds.) *The Post-Bureaucratic Organization: New Perspectives on Organizational Change* (108-128), Thousand Oaks, CA: Sage, 1994.
- [29] National Telecommunications and Information Administration. *Falling through the net: A Survey of the "Have Nots" in Rural and Urban America*, 1995. Available Online: [tp://www.ntia.doc.gov](http://www.ntia.doc.gov)
- [30] O'Hara-Devereaux, M., and R. Johansen. *Globalwork*. San Francisco: Jossey-Bass, 1994.
- [31] Osterman, P. (ed.) *Broken Ladders: Managerial Careers in the New Economy*. New York: Oxford University Press, 1996.
- [32] Pratt, A. "New Media, the New Economy and New Spaces." *Geoforum*, 2000, 31, 425-436.
- [33] Rifkin, J. *The End of Work: The Decline of the Global Labor Force and the Dawn of the Post-Market Era*. New York: G.P. Putnam's Sons, 1995.
- [34] Senior, B.A. and A. Muira. "Developing an Educational Interactive Multimedia Application for Construction Estimating." *Journal of Construction Education*, 1997, 1(2), 105-113.
- [35] Senior, B. "Developing and Using Video Interviews for Construction Education." ASC Proceedings of the 38th Annual Conference, Virginia, 2002.
- [36] Thornburg, L. "Computer-Assisted Interviewing Shortens Hiring Cycle." *HRMagazine*, 1998, 73-79.
- [37] White, G. "Employee Turnover: The Hidden Drain on Profits." *HR Focus*, 1995, 72, 15-17.
- [38] Williamson, O. *The Mechanics of Governance*. New York: Oxford University Press, 1996.

# The Internet Shopping Process: An Empirical Model, Research Findings, and Financial Implications

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## Abstract

Thanks to the tremendous growth of e-commerce, the U.S. economy has gone through rapid facelift. New start-up companies and existing retail power players compete for market position in the new millennium. Traditional retailers engage in business model reengineering to keep up with the changes in how customers acquire goods and services. How to attract on-line shoppers to their sites has become a fundamental task for Internet marketers. The present study examines how on-line shoppers perceive their on-line shopping experience in a major metropolitan area. An Internet shopping model, implications, and future research directions are offered.

## 1. Introduction

The explosion of e-commerce has dramatically changed the landscape of the U.S. economy. The combined monetary value for Internet-related businesses is expected to grow to around \$1.4 trillion by 2003. In the business-to-business sector, Internet technology facilitates numerous infrastructure changes in information exchange and procurement and distribution process. While the business sector accounts for most of the value of Internet commerce (estimated at \$1.3 trillion by 2003), rapid growth in the consumer sector propels traditional retailers to tap into this vast, yet unpredictable, business domain. In 2001, Web retail sales accounted for approximately 2% of total US retail sales. Although the U.S. economy have suffered significant decline since early 2001, the Internet sector continues to expand.

The fast development of the Internet infrastructure introduces new opportunities that are rarely seen in recent world economy. With assistance from the latest advancement in internet technology, on-line marketers rush to establish positions in newly identified niches and to acquire new competitive advantages. One distinct advantage for Internet marketers is the ability to reach a large number of consumers scattering around in various geographic locations, including hard-to-reach areas, in a matter of minutes or hours. Another advantage is its attractiveness to younger generations that are heavily sought after by many marketers, such as Pepsi, McDonald's, and major advertisers. Media spending on the Internet have been estimated to reach \$20 billion by the year of 2001. Adding Internet advertising to the

promotional mix has become a common strategy used by major advertising agencies and marketers. It has been reported that banner advertising on web pages is as effective as typical TV commercials. With more than 50% of the U.S. population are on-line in 2002, marketers have to contemplate how to connect with on-line users effectively and efficiently.

The dramatic growth in e-commerce also introduces new challenges in customer services. More consumers lodge complaints with various consumer agencies. The most common types of complaints concerned Internet marketers include refund and billing disputes, product return policies, defective products, inadequate infrastructure, and poor customer services. Consequently, an ensuing managerial issue is how to evaluate the quality of the consumer's on-line shopping experience. In the long run, on-line marketers who are able to maintain competitive advantage by providing superior shopping experience are more likely to prosper in the newly emerging marketing channel.

The present study examines consumers' on-line shopping experience based on various criteria and explores the determinants of customer satisfaction with on-line purchases. The results provide directions for future research for marketing researchers and managerial implications for on-line marketers. The following issues are examined:

- How do on-line shoppers describe their on-line shopping experience?
- What are the fundamental dimensions of the quality of one's on-line shopping experience?
- How do the underlying dimensions influence on-line shoppers' satisfaction?
- What are the financial consequences?
- Is there a common model of on-line shopping experience?

In-depth interviews were conducted with thirty-five consumers, who had purchased at least once from the Net in the past 12 months, from a major western metropolitan area to gain insight on consumers' perceptions and evaluation of their Internet shopping experience. Consumers were asked to elaborate on the following questions:

- past on-line purchases;
- reasons for buying from the Internet;
- self-described on-line shopping experience;

- intention for repeat purchase;
- issues and concerns for on-line purchases.

The results indicated that consumers bought a wide variety of products from the Net. Books, music CDs, airline tickets, computers, and computer peripherals and supplies were the most frequently mentioned products. When asked why shopped from the Internet, price and convenience were the two main reasons. In addition, respondents also mentioned it was fun to shop or browse on the Internet. For some hard-to-find items, such as supplies and replacement parts for out-of-date computer products, the Internet was the most efficient source. A few consumers also liked the large selection of products offered by Internet marketers.

A questionnaire was developed based on the results from the in-depth interviews. The questionnaire was revised and validated based on a pretest with a few experienced on-line shoppers. Prospective on-line shoppers were selected and recruited using a cluster sampling procedure. Interviewers were instructed to contact and recruit a number of respondents in their assigned neighborhood through telephone inquiries. Respondents were requested for referrals for other potential on-line shoppers from the same neighborhood. Data collection was completed a week before the Christmas shopping season. The procedure yielded 306 valid responses.

## 2. Results

Seven common attributes, price, convenience, quality, variety, immediacy (immediate interactive response), hard-to-find, and fun, were identified from in-depth interviews. Respondents were asked to choose the primary reason for shopping on-line and rank all listed reasons. Convenience was the most frequently chosen reason for shopping on-line, followed by price. When asked to rank all of the attributes, price was ranked as the most important factor, followed closely by convenience. Price and convenience were clearly the two main reasons that respondents chose to shop from the Internet.

Respondents' shopping experience was measured by a variety of items based on the findings from in-depth interviews. An overall satisfaction rating of 4.34 on a five-point scale (5=very satisfied) indicated a high level of satisfaction. Among all respondents, 87.1% indicated that they were satisfied or very satisfied with their on-line shopping experience. On various experience items, convenience-related items, such as ease of transaction and overall convenience, received high favorable ratings. While respondents generally believed that on-line transactions were of good value (with an average rating of 4.10), the relative cost comparison with those transactions made in regular stores was not as favorable as expected (an average of 3.89). In fact, 29% of respondents rated regular stores as less costly. Furthermore, most respondents considered shopping on-line was not as

secure as shopping at regular stores. It indicated a general security concern for on-line transactions. Their responses to follow-up questions on respondents' concern over a list of factors validated this result. Security, privacy, and fraud were the most concerned by the respondents.

To identify the underlying influential factors that determined one's overall satisfaction with on-line transactions, regression analyses were performed with overall satisfaction on each of the experience items respectively. The results indicate that twelve items have significant influence on overall satisfaction. Ease of transaction, comfort in transaction, and excitement were the top three factors that influenced customer satisfaction in the regression analysis. A stepwise regression was performed with customer satisfaction on the fourteen experience factors. The yielded regression model included three factors, ease of transaction, comfort in transaction, and excitement, with an R-square value of 0.47, consistent with the findings from simple regression analyses. Finally, on-line shoppers are more likely to shop more and pay more with merchants who provide superior shopping experience. The results indicate expected expenditure and profit margins increase with the level of positive experience. Overall, positive on-line shopping experience correlates with financial returns.

Overall, 70.5% of respondents indicated that they are very likely or likely to purchase from the Net again in the next six months. The results show strong increase across all product categories among respondents. Books, Music CDs and tapes, and airline tickets have the highest interest level. Overall, respondents anticipate making more purchases from the Internet in the next six months.

The results validate the findings from in-depth interviews. Three clusters of factors were identified. One cluster is related to Internet connection and quality of hardware and software. The second cluster is related to on-line interactive shopping experience. The third cluster is post-order fulfillment and service. They are named **Interactivity, transactional experience, and fulfillment and service**, respectively.

**Interactivity** factors determine the quality of interactive exchange between a shopper and a vendor's web site. It encompasses connection factors of consumers, ISPs, and e-tailers. The quality of personal computers used by a consumer and the speed of adopted connection methods as well as connection quality and website quality of both ISPs and e-tailers are identified as important factors.

**Transactional experience factors** are those involved in the on-line transactional process. A factor analysis reveals a factor structure with five common factors of value, assurance, entertainment, convenience, and evaluation.

**Fulfillment and service factors** are integral part of e-tailing as vendors have to rely on reliable shipping agents and superior service personnel to deliver high-quality on-line shopping experience. E-tailers who are able to offer efficient fulfillment and worry-free

services, such as convenient return and exchange policies, are more likely to proper than many hit-and-run on-line marketers who offer little service and warranty.

Factor analysis was employed to estimate the three components of on-line shopping experience: interactivity, transaction, and fulfillment. An overall interactivity measure was obtained via a single factor analysis, which explains 42% of the total variance. Similarly, two single factor solutions were obtained, explaining 39% of the total variation of the transaction factors and 45% of the total variation of the fulfillment factors, respectively. The single factor solutions were used in the subsequent analysis in testing the individual effects of interactivity, transaction, and fulfillment.

Regression analyses were employed to examine the effects of the interactivity, transaction, and fulfillment factors on the overall satisfaction. First, effects of the interactivity, transaction, and fulfillment factors were estimated separately by single regression analysis. The results indicate that transaction has the greatest effect among the three factors, while all three factors show a significant effect ( $p < 0.01$  for all three factors; see Table 1). When all three factors were included in a multiple regression model, only transaction and interactivity have a significant effect. This finding indicates a strong correlation among the three factors. The multiple regression model explains 31% of the total variation in overall satisfaction.

**Table 1: The Effects of Interactivity, Transaction, and Fulfillment**

Dependent Variable:	Overall Satisfaction			
Independent Variables:	??*	??*	??*	??*
<b>Interactivity</b>	0.425 <sup>a</sup>	0.218 <sup>a</sup>	---	---
<b>Transaction</b>	0.524 <sup>a</sup>	0.423 <sup>a</sup>	---	---
<i>Value</i>	---	---	0.463 <sup>a</sup>	0.199 <sup>a</sup>
<i>Convenience</i>	---	---	0.473 <sup>a</sup>	0.227 <sup>a</sup>
<i>Assurance</i>	---	---	0.382 <sup>a</sup>	0.038
<i>Evaluation</i>	---	---	0.422 <sup>a</sup>	0.163 <sup>b</sup>
<i>Entertainment</i>	---	---	0.324 <sup>a</sup>	0.025
<b>Fulfillment</b>	0.411 <sup>a</sup>	-0.008	---	---
R-square	---	0.310	---	0.290
n	306	306	306	306

\*Standardized beta coefficients based on single regression analysis

\*\*Standardized beta coefficients based on multiple regression analysis

a.  $p < 0.01$

b.  $p < 0.05$

Further analyses were conducted to examine the effects of the five transaction components on on-line shopping experience. Again, individual effects of the five components were estimated using simple regression analyses. All standardized betas are significant at the 0.01 level. As expected, convenience has the greatest effect, closely followed by value. When all five components were

included in a multiple regression model, only the convenience, value, and evaluation factors have a significant effect. The results suggest a strong correlation among the five components of the transaction factor.

## 2.1 Financial Implications

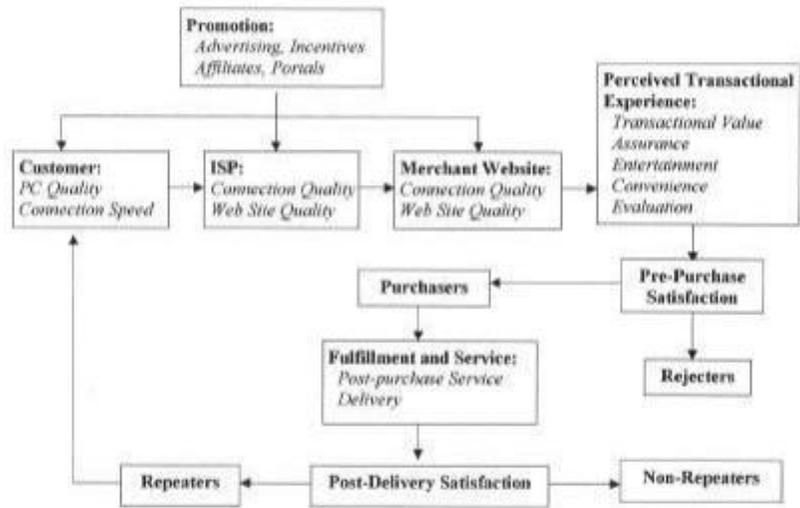
The final research question is how does one's overall satisfaction with the on-line shopping experience affect a company's performance based on anticipated financial returns. Respondents show unambiguous willingness to shop more frequently and pay a higher price in exchange for higher level of satisfaction. When group respondents based on their level of satisfaction, on average, respondents in the high satisfaction group indicate the willingness to pay a 14% premium than those in the low satisfaction group. In addition, respondents in high satisfaction group will purchase 2.5 times more frequently. Assuming a 20% profit margin, such high satisfaction will translate into a potential increase in profitability by 4.25 times for an on-line marketer who is able to provide high level of satisfaction.

## 3. Discussion

On-line shoppers from a major metropolitan area reported a high level of overall satisfaction and strong intention to repeat on-line purchases. Although convenience and price were rated as the two most important factors and security as the greatest concern for on-line transactions, the fun factor (excitement in on-line shopping) had the strongest simple effect on overall satisfaction. Ease of transaction and comfort in transaction were the other two significant determinants of satisfaction. Security had little marginal effect on one's overall satisfaction with on-line purchases. On-line merchants who offer superior shopping experience are likely to reap significant financial benefits because shoppers are willing to pay more and shop more frequently.

A model of the consumer on-line shopping process is proposed based on the findings. It is a general model that applies to most on-line shopping. Future research needs to address the fitness of the model and how this model can be used to predict customer satisfaction. The measurement issue on the quality of on-line shopping transactions or experience and how one's shopping experience and various factors determine future patronage are also important future research issues.

The Figure: NetShop - A Model of On-line Shopping Experience



# Internet Advertising: A Comparison of Pricing Strategy

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## Abstract

The primary objective of this study is to explore the various ways that Internet advertising provider (IAP) can charge firms to advertise. There are two pricing strategies that can be adopted. The first is called *uniform pricing*: Firms pay a fixed fee, depending on the size and location of the advertisement. The second strategy is known as *two-part tariff*: Firms pay a fixed charge and an additional per-click fee. IAPs may adopt one or both of these pricing strategies. Our model hypothesizes that there are two IAPs offering advertising space. The modeling shows that in cases where a uniform pricing strategy is adopted, the fee that each IAP can attain is monotonically decreasing over their substitutability. That is, IAPs that wish to maximize their revenue have to take measures to distinguish themselves from the competition in order to achieve zero substitutability. In cases where a two-part tariff pricing strategy is adopted, the revenue curve becomes convex. In other words, IAPs may choose to have either full substitutability or zero substitutability in order to maximize their profits.

## 1. Introduction

The ever-increasing expansion of the Internet has led to the dominance of Internet companies such as Amazon and Yahoo!. These companies offer not only their own services but also advertising space to firms wishing to promote their products or brands. Hereafter, these companies are referred as Internet Advertising Providers (IAPs). Visitors to these sites can access their services and also find themselves directed to other sites by simply clicking on banners on the Internet pages. For the surfer, these banners are no more than just icons offering access to other websites. However, for IAPs that go to great expense to construct and maintain these websites, these banners may be the only source of revenue. In other words, double clicking on those banners has becoming a new medium in advertising. This has led to the creation of a new advertising industry called Internet marketing.

In terms of the significance of Internet marketing, although its popularity began only a few years ago, its potential is tremendous. In

the US for example, the revenue from Internet advertising amounted to \$2 billion in 1998, according to a report by the Internet Advertising Bureau (IAB, 2000). The same report also estimates this may have exceeded \$4 billion in 1999. In Japan, the revenue from Internet advertising is estimated at ¥11.4 billion in 1998. In Taiwan, the Internet advertising revenue is estimated at NT\$100 million (Yeh, 2000). Compared to the annual advertising budget of NT\$80 billion in Taiwan, this is only a fairly small portion. Nevertheless, with a growth rate that has doubled annually in the past few years, this clearly should not be ignored.

Internet marketing is not only significant in this practical way but is also important in academic terms, with research into areas such as pricing and competition. Generally, IAPs may collect revenue from two sources: Advertisement Impression (AI) and Click Through Rate (CTR). AI represents an advertisement delivered successfully to a qualified visitor. A qualified visitor is one who has the opportunity to view the advertisement. Therefore, this does not include cases where sites bearing the advertisement are simply listed as results of a search. Clearly, visits to those sites by internal users are also excluded. CTR represents the number of times visitors click on an advertisement banner and are then directed to the target site. For payment purposes, firms that wish to have a banner on an IAP's web page are usually asked to pay a lump sum fee. Hereafter this lump sum fee is referred to as the AI fee. If a visitor clicks on their banner and is successfully directed to the target site, the provider may then collect a running payment according to the number of clicks each banner receives. Hereafter, this running payment is referred as the *referral fee*. (In some cases, however, the provider may choose not to charge unless this results in a business for the target site.) An interesting question is how the provider can set those fees. Do pricing strategies exist that can help providers maximize their revenue?

### 1.1. Internet vs. traditional advertising media

We begin our investigation of those questions by comparing the practice of Internet advertising with other traditional forms of

advertising media, such as magazine, TV and radio. It has always been a challenge in measuring the effectiveness of advertising with traditional media. This may be due to the lack of accurate ways to assess the link between traditional advertising and consumer purchasing behavior. Therefore, traditional media can only charge clients according to impression numbers. However, one significant difference we can see in Internet advertising is that CTR tracing technology provides a much better estimate of the power of advertisements. The server proxy offers a detail recording on Internet visitors' clicking actions. Furthermore, if firms can agree to inform providers when visitors make a purchase, then the effectiveness of advertisements can be measured with the utmost accuracy. In this case, firms can pay a referral fee only for "successful" advertising.

## 1.2. Non-linear pricing

Since the missing link in measuring the advertising effectiveness between advertising and purchase in traditional advertising media can be recovered with the CTR technology via Internet, the next question is what pricing strategy (uniform pricing or two-part tariff) will the IAPs employ to maximize their profit. Is two-part tariff a superior pricing strategy to uniform pricing, which is widely adopted in the area of traditional advertising media? Among the several tariff schemes in nonlinear pricing strategy, two-part tariff is the most widely used pricing strategy. Firms pay a fixed charge and an additional per-click fee. From the provider's viewpoint, the fixed fee is less attractive to firms but results in higher overall revenue (Wilson, 1992). Nahata, et al. (1999) show that "..., a fixed investment that ...reduces future transaction cost, a two-part tariff [or multi-part tariff]... becomes more profitable (than uniform price)." Compared with the huge investment involved in website development, the cost of putting a banner on a web page is negligible. In other words, the nature of Internet advertising may favor the two-part (or maybe multi-part) tariff system.

Since the introduction of the Internet, an impression has been created that the cost of doing things through the net is negligible. For example, to the providers the cost of placing advertisement banners on web pages is negligible. However, the space on a web page is limited and quite often for the same page there will be only one type of firm able to advertise. Consequently, firms may have to compete for the space, which drives the price up. Another difficulty is that when the impression rate or the CTR is high, this may use up the bandwidth and

slow down the transmission speed. This can cause visitors to lose patience. In this regards, providers do indeed have a variable (opportunity) cost. This gives a reference for us to model the marginal cost in the following sections.

Given that, however, in the Internet's very short history we have observed quite a few cases that uniform pricing (or sometimes referred to as "buffet pricing" in Nahata, et al. (1999)) is more viable than the two-part tariff. A significant example is the case of America Online. America Online is an Internet service provider (ISP). It was the first significant ISP to provide a flat rate for users to connect with the Internet. Other ISPs were then forced to provide a flat rate (uniform pricing) strategy to stay in the market. In Taiwan uniform pricing was implemented on the wide band system put on market in 1999. To some extent, this study explains the pricing behavior above.

The next section shows model without the referral fee, which follows the uniform pricing strategy. Section 3 shows the model that allows the use of referral fee, which follows the two-part tariff strategy. Related issues and future studies are addressed in Section 4.

## 2. Model without referral fee

For nonlinear pricing strategy, such as the two-part tariff, to be successful firms must be heterogeneous and providers must have monopolistic market power (Wilson, 1992; Oi, 1971). However, in practice very similar oligopolistic competitors may compete using the two-part tariff strategy. For example, China Times and United Daily News both provide web pages for advertisements, and they both price their banners on a two-part tariff basis. Hence, for simplicity, we will setup our model by assuming that the IAPs compete in duopoly and firms are assumed to be either light users or heavy users. □

Moving onto the modeling in a fashion of two-part tariff, it is necessary to set the demand profile of the buyers by assuming they are homogenous (Nahata, et al., 1999). Although the homogenous assumption seems unrealistic, the simplified situation may help to clarify this complexity. Furthermore, it may help to justify the results derived from the heterogeneous

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<sup>1</sup> If providers have information in regard to the light and heavy usage, they may charge different fixed fees with respect the two types of firms. The fixed fees reflect the consumer surpluses of the firms. However, in most cases, the provider does not have this information. As a result, the provider may charge a fixed fee according to the surplus that the light users have, and set a per-unit price equal to the marginal cost for both types users.

assumption.

Next, according to Wilson (1992), if the following four preconditions are satisfied, sellers may adopt a nonlinear pricing strategy, such as two-part tariff. The four preconditions are as follows (Wilson, 1992, p.10) :

- The seller has a monopoly of power.
- Resale markets are limited or absent.
- The seller can monitor customers' purchases.
- The seller has disaggregated demand data.

Although in the Internet industry, IAPs are far from monopolistic in their areas, as long as the competition is imperfect the first precondition is not completely violated. Resale is also unlikely in the Internet advertising market, because the advertisements have to be placed directly with the provider. The firm is thus unlikely to resell its advertising space to a third party without releasing the resale information to the provider. As mentioned above, existing information technology can allow the provider to record the CTR precisely. That is, the third precondition can at least be partially satisfied. The last precondition is assumed in the present study. Therefore, a nonlinear pricing strategy is justified for our modeling of Internet advertising as follows.

Consider that there are two Internet advertisement providers (IAPs), say  $M_i, i = 1, 2$ . These two providers offer web pages for firms that need to place advertisements to promote their brand or increase sales. The two providers may compete with each other on price ( $p_i, i = 1, 2$ ). The price of an advertisement may depend on the web pages ( $q_i, i = 1, 2$ ) that are available. There may exist certain substitutability between web pages on the two providers' websites. Set  $\alpha$  the substitutability and assume the demands for the two as

$$p_1 = a_1 - b_1 q_1 - \alpha q_2, \text{ and}$$

$$p_2 = a_2 - b_2 q_2 - \alpha q_1$$

Assume the manufacturing costs are  $c_i, i = 1, 2$ . Then the profits for each provider are

$$\pi_i = (p_i - c_i) q_i, \text{ where } i = 1, 2.$$

This model is no different to that used for traditional advertising media. Hence we call it

<sup>2</sup> Further agreements between the firm and the provider would be needed to share information regarding final purchases if one would like to have a perfect measure of the link in advertising effectiveness mentioned earlier.

the benchmark model. Later we will use this benchmark to demonstrate the differences between traditional advertising media and Internet advertising.

The solutions to the benchmark model are

$$q_1^N = \frac{1}{b_1 - \alpha^2} (p_1 - c_1), \text{ and}$$

$$q_2^N = \frac{1}{b_2 - \alpha^2} (p_2 - c_2), \text{ where the } N \text{ stands}$$

for the Nash equilibrium.

In Appendix 1, we calculate the Nash prices as follows.

$$p_1^N = \frac{1}{4 - \alpha^2} (2a_1 - \alpha a_2 - 2c_1 - \alpha c_2)$$

$$p_2^N = \frac{1}{4 - \alpha^2} (2a_2 - \alpha a_1 - 2c_2 - \alpha c_1)$$

In addition to those results, we are particularly interested in profit changes over the choice of the level of substitutability ( $\alpha$ ). This derivative in the next equation is derived in Appendix 2.

$$\frac{\partial \pi_1}{\partial \alpha} = \frac{2(p_1^N - c_1) \alpha}{b_1 - \alpha^2} - \frac{2(p_1^N - c_1) \alpha}{4 - \alpha^2} - A_p \alpha B$$

where

$$A_p = \frac{2(p_1^N - c_1)}{b_1 - \alpha^2}$$

$$B = \frac{2(p_1^N - c_1) \alpha}{4 - \alpha^2} - \frac{2(p_1^N - c_1) \alpha}{b_1 - \alpha^2} - \frac{2(p_1^N - c_1) \alpha}{4 - \alpha^2} - \frac{2(p_1^N - c_1) \alpha}{b_1 - \alpha^2} - \frac{2(p_1^N - c_1) \alpha}{4 - \alpha^2} - \frac{2(p_1^N - c_1) \alpha}{b_1 - \alpha^2}$$

Set  $\frac{\partial \pi_1}{\partial \alpha} = 0$ , and we then have

$$\frac{2(p_1^N - c_1) \alpha}{b_1 - \alpha^2} - \frac{2(p_1^N - c_1) \alpha}{4 - \alpha^2} = 0$$

Assume  $A_p \alpha B = 0$ , that is  $\frac{2(p_1^N - c_1) \alpha}{b_1 - \alpha^2} = 0$ , then

$$\frac{2(p_1^N - c_1) \alpha}{b_1 - \alpha^2} - \frac{2(p_1^N - c_1) \alpha}{4 - \alpha^2} = 0$$

Reorganize the equation,

$$\Rightarrow \frac{2(p_1^N - c_1) \alpha}{1 - \alpha^2} = \frac{d(p_1^N - c_1)}{d\alpha}$$

To solve the equation, let

$$x = (p_1^N - c_1) \text{ and } x = \frac{2(p_1^N - c_1) \alpha}{1 - \alpha^2}, \text{ and}$$

we then have

$$1 - \alpha^2 = \frac{dx}{d\alpha} x$$

Through the reorganization of this

equation, we have

$$\frac{dx}{d\alpha} - 2\alpha x + \frac{dx}{d\alpha} = 0.$$

The solutions to the above equation are as follows.

$$\alpha_1^* = \frac{x \pm \sqrt{x^2 - 4x^2}}{2x} = 1, \quad \text{or}$$

$$\alpha_2^* = \frac{x \pm \sqrt{x^2 - 4x^2}}{2x} = 0.$$

Figure 1 shows a plot of  $\frac{\alpha_1}{\alpha}$  over  $\alpha$ .

This graph could be reversed into  $\alpha$  over  $\frac{\alpha_1}{\alpha}$  as shown in the graph below. Since the  $\alpha$  only makes sense between zero and one, according to the graph above, the provider's profit is maximized if  $\alpha$  is minimized. This result implies that if a referral fee does not exist between the provider and the advertiser, it is better for the provider to fully distinguish its market position from that of its competitors. Nevertheless, it might be interesting to study further the case in which one provider is the anchor and other providers move closer to its market position.

### 3. Model with referral fee

The next model is set to consider the way in which referral fee can be collected via the application of CTR technology. Typically, the provider may collect a one-off advertising fee at the outset. In addition, the provider may collect a referral fee for each visitor that clicks on the advertiser's banner and is directed to the advertiser's website.

In addition to the assumptions and notations we made in the benchmark model, we add the referral fee to our model as follows.

$$\begin{aligned} P_1 &= a_1 + b q_1 + q_2 & (1) \\ P_2 &= a_2 + b q_2 + q_1 & (2) \end{aligned} \quad \text{Macleod model}$$

$$q_1 = P_1 q_1 + C_1 q_1 + r_1 k_1 \quad (3)$$

$$q_2 = P_2 q_2 + C_2 q_2 + r_2 k_2 \quad (4)$$

$r_i, i = 1, 2$  represent the referral fee per click and  $k_i, i = 1, 2$  represent the number of clicks.

By reorganizing the equations (1) and (2), we have

$\Rightarrow$

$$q_1 = \frac{1}{b(1 - \alpha^2)} [a_1 + a_2 - P_2 - P_1]$$

$$q_2 = \frac{1}{b(1 - \alpha^2)} [a_2 + a_1 - P_1 - P_2]$$

Also, by substituting these equations into equations (3) and (4), we derive the profit functions as follows.

$$\pi_1 = P_1 C_1 q_1 + r_1 k_1 - \frac{1}{b(1 - \alpha^2)} [a_1 + a_2 - P_2 - P_1] P_1 C_1 + r_1 k_1$$

$$\pi_2 = P_2 C_2 q_2 + r_2 k_2 - \frac{1}{b(1 - \alpha^2)} [a_2 + a_1 - P_1 - P_2] P_2 C_2 + r_2 k_2$$

By setting  $\frac{\partial \pi_1}{\partial P_1} = 0$ , we derive the Nash

equilibria as follows.

$$q_1^N = \frac{1}{b(1 - \alpha^2)} [P_1 + C_1] - \frac{r_1}{P_1} k_1$$

$$q_2^N = \frac{1}{b(1 - \alpha^2)} [P_2 + C_2] - \frac{r_2}{P_2} k_2$$

Substitute the two equilibria into equations (1) and (2), and we get

$$\begin{aligned} a_1 + C_1 + a_2 + C_2 - P_2 - C_2 - 2P_1 &= 0 \\ 2C_1 + b(1 - \alpha^2) \frac{r_1}{P_1} k_1 - 0, r_1 &= \frac{r_1}{P_1} \\ a_2 + C_2 + a_1 + C_1 - P_1 - C_1 - 2P_2 &= 0 \\ 2C_2 + b(1 - \alpha^2) \frac{r_2}{P_2} k_2 - 0, r_2 &= \frac{r_2}{P_2} \end{aligned}$$

The Nash price equilibria are then arrived at as follows.

$$P_1^N = \frac{1}{4(1 - \alpha^2)} [2(a_1 + a_2) + 2C_1 + C_2 - b(1 - \alpha^2)(2r_1 k_1 + r_2 k_2)]$$

$$P_2^N = \frac{1}{4(1 - \alpha^2)} [2(a_2 + a_1) + 2C_2 + C_1 - b(1 - \alpha^2)(2r_2 k_2 + r_1 k_1)]$$

As in the benchmark model, we are interested in the profit change over the substitutability. That is,



is not possible to collect the referral fee. This may be one reason why the referral fee system is rarely employed. However, if there is technology that can tell if a purchase is made, then the referral fee system is actually superior to the click through rate from the viewpoint of performance-based pricing.

Perhaps the most significant case for using the two-part tariff strategy is in the area of franchising. According to the literature on franchise, the widely employed payment strategy between franchiser and franchisee includes the franchise fee (a fixed fee) and running royalty (per unit charge). This reflects an important consideration that the running royalty provides incentives for the franchisee to work diligently without close monitoring by the franchiser (Bhattacharyya and Lafontaine, 1992; Lal, 1990). In addition, this payment strategy can encourage franchisers to do their best to promote their trademark and products to increase franchisees' sales volume. For all these reasons, this may be why the two-part tariff is widely adopted in franchising. Nevertheless, the popularity of the uniform pricing strategy by ISPs provides a good reason for us to investigate this strategy in future study.

## References

- [1] IAB (Internet Advertising Bureau), 2000, IAB Internet Advertising Revenue Report, <http://www.iab.com/>.
- [2] Lal, Rajiv, 1990, Improving channel coordination through franchising. *Marketing Science* 9 (40), 299-318.
- [3] Nahata, Babu, Krzysztof Ostaszewski, and Prasanna Sahoo, 1999. Buffet Pricing, *Journal of Business*, 72(2), pp.215-228.
- [4] Oi, Walter, 1971. A Disneyland dilemma: Two-part tariffs for a Mickey-Mouse monopoly, *Quarterly Journal of Economics* LXXXV, pp. 77-96.
- [5] Wilson, Robert B., 1992. *Nonlinear Pricing*, Oxford University Press, New York.
- [6] Yeh(葉向榮), 2000, The bottle neck for the thriving of Internet advertising in Taiwan(台灣網路廣告存在的瓶頸), <http://www.ctech.com.tw/columns/>.

## Appendix 1

The price-reaction functions are as follows.

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business is attained within IAP's websites. This design enables the IAP a perfectly monitoring whether or not a business is attained. Nevertheless, it will become a contractual problem, which is not a consideration of the present study.

$$\begin{aligned} & a_1 C_1 - a_2 C_2 - 2P_1 C_1 = 0 \\ & a_2 C_2 - a_1 C_1 - 2P_2 C_2 = 0 \\ \Rightarrow & a_1 C_1 - a_2 C_2 = 2P_1 C_1 \\ & a_2 C_2 - a_1 C_1 = 2P_2 C_2 \end{aligned}$$

If we take (a)  $\frac{1}{4} \frac{a_1^2}{a_2^2} (b)$ , then

$$\Rightarrow P_1^{Nash} = \frac{1}{4} \frac{a_1^2}{a_2^2} (2a_1 - a_2 - 2C_1 - C_2)$$

Same for

$$P_2^{Nash} = \frac{1}{4} \frac{a_2^2}{a_1^2} (2a_2 - a_1 - C_1 - 2C_2)$$

## Appendix 2

Following our definitions and the results in Appendix 1, we have the following in profit, Nash price and Nash quantity.

$$\begin{aligned} q_1 &= \frac{1}{b_1} \frac{P_1^N}{C_1} \\ P_1^N &= C_1 \frac{1}{4} \frac{a_1^2}{a_2^2} (2a_1 - a_2 - C_1 - C_2) \\ q_1^N &= \frac{1}{b_1} \frac{P_1^N}{C_1} \end{aligned}$$

Firstly, the derivative of the price to the substitutability is

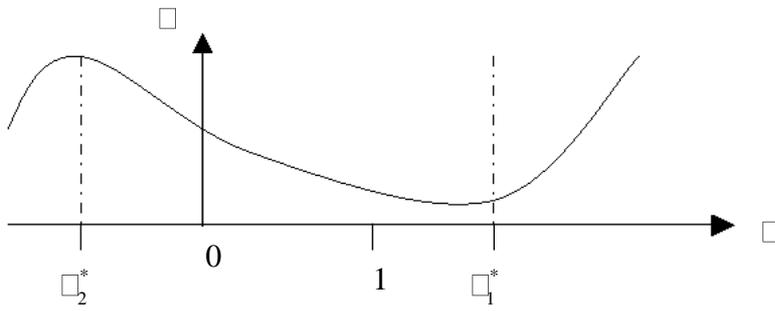
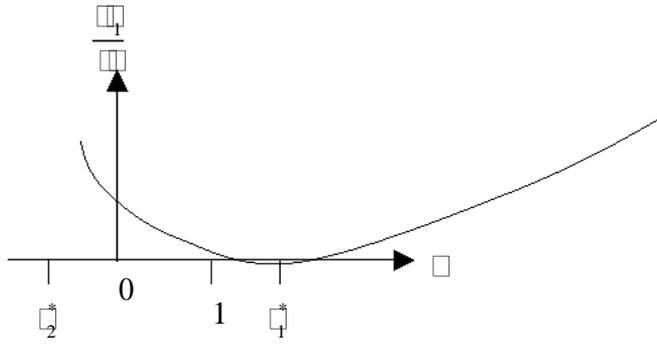
$$\begin{aligned} \frac{\partial P_1^N}{\partial C_1} &= \frac{2}{4} \frac{a_1^2}{a_2^2} (2a_1 - a_2 - C_1 - C_2) \\ &= \frac{1}{4} \frac{a_1^2}{a_2^2} (2a_1 - a_2 - C_1 - C_2) \\ &= \frac{2}{4} \frac{a_1^2}{a_2^2} \frac{1}{4} \frac{a_1^2}{a_2^2} (2a_1 - a_2 - C_1 - C_2) \end{aligned}$$

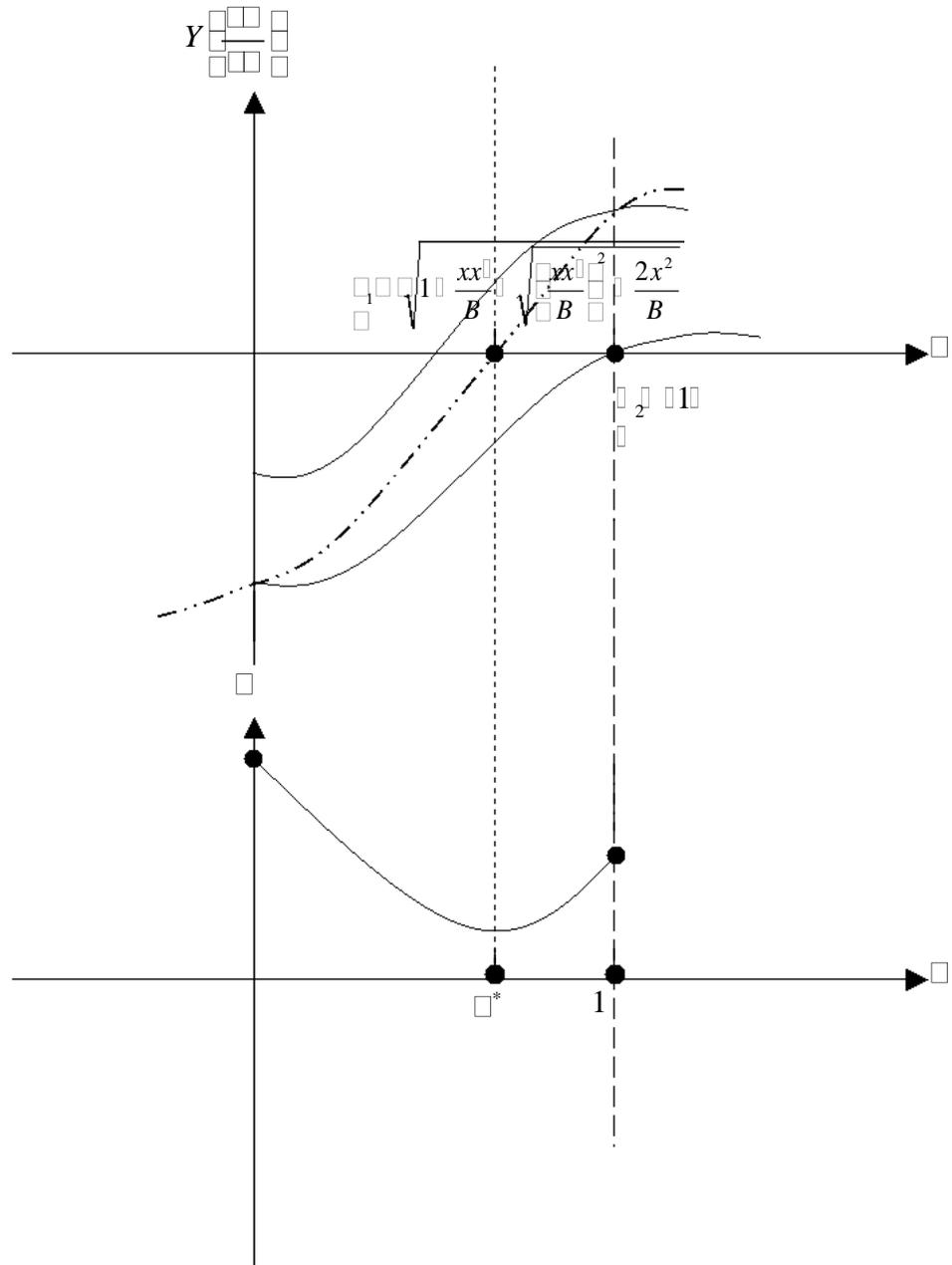
and the derivative of the quantity to the substitutability is

$$\begin{aligned} \frac{q_1^N}{b_1} &= \frac{1}{b_1} P_1^N C_1 \\ &= \frac{2}{b_1} P_1^N C_1 \frac{1}{b_1} P_1^N C_1 \\ &= \frac{1}{b_1} \frac{2}{1} P_1^N C_1 \frac{2}{4} P_1^N C_1 \frac{1}{4} [2 C_1 - 2 a_1 C_1 - C_2 a_2 C_2] \\ &= \frac{1}{b_1} \frac{2}{1} \frac{2}{4} P_1^N C_1 \frac{1}{4} [2 C_1 - 2 a_1 C_1 - C_2 a_2 C_2] \end{aligned}$$

The two jointly deliver the profit to substitutability derivative as follow.

$$\begin{aligned} \frac{q_1}{b_1} &= \frac{1}{b_1} P_1^N C_1^2 \\ &= \frac{2}{b_1} P_1^N C_1^2 \\ &= \frac{1}{b_1} \frac{2}{1} P_1^N C_1 \frac{P_1^N C_1}{1} \\ &= \frac{2 P_1^N C_1}{b_1} \frac{1}{1} P_1^N C_1 \frac{P_1^N C_1}{1} \\ &= \frac{2 P_1^N C_1}{b_1} \frac{1}{1} \frac{2}{4} P_1^N C_1 \frac{1}{4} [2 C_1 - 2 a_1 C_1 - C_2 a_2 C_2] \\ &= \frac{2 P_1^N C_1}{b_1} \frac{1}{1} \frac{2}{4} P_1^N C_1 \frac{1}{4} [2 C_1 - 2 a_1 C_1 - C_2 a_2 C_2] \end{aligned}$$





# 4Ws E-Marketing Strategy: A Conceptual Framework of its Antecedents and its Consequences on Web Performance

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## Abstract

While building on the contingency theory, this paper proposes a conceptual framework that links five factors: a) internal forces, b) external forces, c) past web and firm performance, d) current web and firm performance, and e) e-marketing strategy in terms of the strategy defined for the 4Ws (Web-Design, Web-Promotion, Web-Price, and Web-CRM). These dimensions and respective variables are explored, and propositions about their relationships are presented. The role of past performance on strategy formulation in an internet context and on current performance is also considered. Future research is encouraged to build on this framework to test how internal and external forces of the firm, along with its past performance, influence the determination of e-marketing strategy and how in turn, e-marketing strategy impacts on performance at the web and firm levels. Ultimately, the present research seeks to identify effective e-marketing practices in order to help managers and in order to guide public policy makers deciding what to support.

## 1 Introduction

The Internet provides firms with an unprecedented ability to communicate directly with customers. With the relatively widespread adoption of the Internet, businesses of all sizes have the opportunity to build competitive advantage. But regardless of any technological opportunities, competitive advantage still rests on a business opportunity to provide outstanding customer service. The real opportunities for sustainable advantage lie with those who recognize the importance of using information technology to improve service in all phases of the customers' involvement with the firms' product or services.

The Internet is assumed to be an important channel for marketing and distribution of products and

services. This is, among other things, due to the cost-effectiveness of the Internet and the convenience for customers. With the Internet marketers can reach out to a broad customer base, locate target customers, identify their needs and communicate with them at a relatively low cost. The Internet provides an opportunity for market testing and optimization. Increasing digitalization will make it progressively easier to experimentally alter particular aspects of a business and quickly observe how customers respond [69]. As of February 2002, 544 million people had Internet access (www.nua.com).

Since the Web allows access to a plethora of information on different products, the organization must encourage the potential consumer to use the Web site as both an information tool as well as a purchase option. This combination of information search and purchase process is an advantage over traditional retailing as online consumers have stated that personalized targeting is a reason they shop online. When consumers are more involved in the buying process it significantly improves brand recognition and recall. According to Bontis and De Castro [4], the best customer-retailer Internet system possesses four characteristics: full product/service descriptions, customer purchase history, community information and facilitation of target marketing.

## 2 Research Objectives

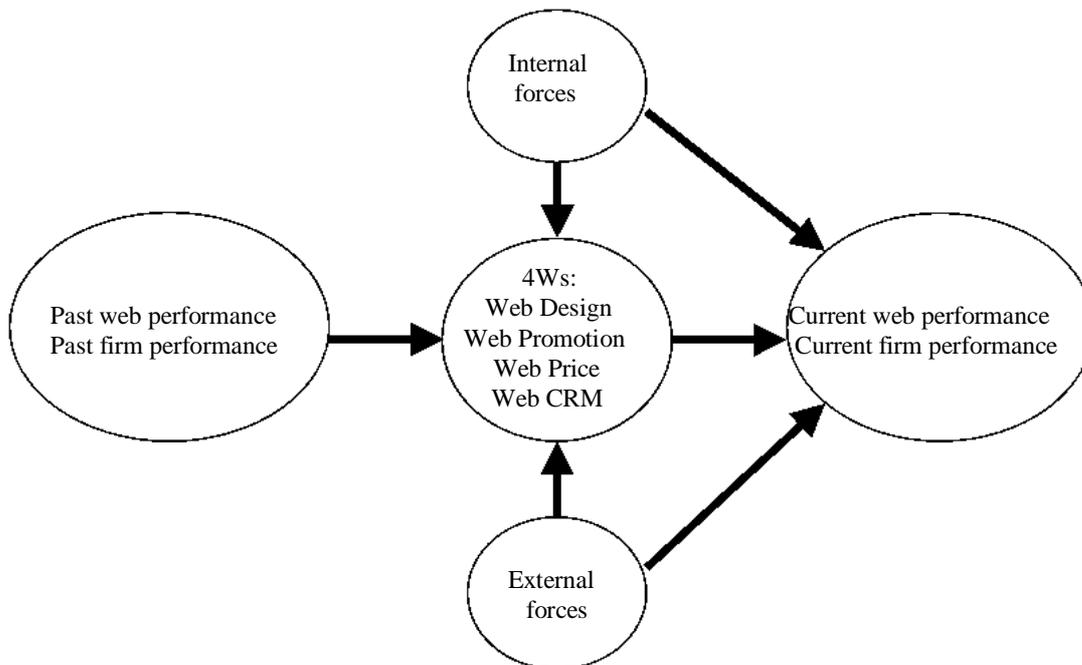
There are three main objectives of this research, the first of which is to extend our understanding of the contingency theory, particularly in an e-marketing context. This is accomplished by presenting a more comprehensive understanding of the simultaneous links among the internal and external forces of the firm, e-marketing strategy, and performance. Earlier marketing research has just focused on single relationships among these variables (e.g., the relationship between strategy and performance or the relationship between contingency

forces and strategy), while rarely considering their simultaneous effects. A contingency approach allows for a multi-faceted approach of the phenomenon. We also advance past work on marketing strategy, which traditionally focuses on a single marketing-mix element, to consider the full marketing mix in a web context.

The second objective of this work is to consider the role of past performance on marketing strategy formulation and on current performance in an internet context. Historically, marketing strategy formulation is viewed as an antecedent to performance outcomes [41]. A recent review of the top journals in strategy and organizational behavior indicates that 79% of the articles incorporating performance have cast it as a dependent variable, while only 9% of the studies have used it as an independent variable [48]. Past performance can be a critical variable in the determination of e-marketing strategy, and the evaluation of current period

performance. Research outside e-marketing e.g., [1][ 11], suggests that when firms experience poor performance they are more likely to search broadly for information and conduct in-depth analyses of their surrounding environments. In contrast, a good performance might promote more relaxed and effortless strategic decisions [24][ 40], as the firm may also become less critical about previous decisions [29], contributing to a narrow focus and preoccupation with the factors that contribute to performance at the expense of remaining responsive to all possible internal and external factors.

The third objective is to study how an articulated approach of four critical e-marketing strategy tasks – the 4 Ws (Web-Design, Web-Promotion, Web-Price and Web-CRM) – relates with current performance. Figure 1 presents the conceptual framework that incorporates past performance, internal and external forces of the firm, e-marketing strategy, and current performance.



**Figure 1 - A contingency framework of the relationship between e-marketing strategy and performance**

### 3 Theoretical Background

#### 3.1 The Contingency Theory

This paper is based in the contingency theory, which has its early roots in the general systems theory [5] [66] and in the behavioral theory of the firm [11][ 43][ 59]. Over the last four decades this perspective has been widely accepted in the field of marketing research [71].

This theory defends that does not exist the best strategy across situations. Performance levels result from the co-alignment among strategy and the firm’s context (i.e., the internal and external forces). Each strategy may be, or not, the best depending on the nature of the contingent forces. Hence, while building on the contingency approach, we propose the following research propositions (see figure 1).

Proposition 1: Depending on the nature of the internal factors, performance might be:

- positively or negatively affected by these factors;
- directly affected by these factors; and
- indirectly affected by these factors through their influence on e-marketing strategy.

Proposition 2: Depending on the nature of the external factors, performance might be:

- positively or negatively affected by these factors;
- directly affected by these factors; and
- indirectly affected by these factors through their influence on e-marketing strategy.

Proposition 3: There is a relationship between performance levels in the past year and performance levels in the current year. This relationship might be:

- positive or negative depending on the nature of the contingent forces;
- direct; and
- indirect, through the influence of past performance on e-marketing strategy.

Based on the marketing literature, we now propose some elements to operationalize internal and external forces, e-marketing strategy, and performance (see Figure 1).

## 3.2 Internal Forces

The marketing literature suggests a variety of internal forces, ie, corporate forces at the institutional and individual levels, which are relevant for e-marketing strategy and performance.

### 3.2.1 Organizational Innovation

Organizational innovation is a function of management that seeks to create new solutions for existing or potential problems. Many studies demonstrated the link between innovation and business performance [14] [ 16] [ 17]. Today's intensification of competition and of environmental uncertainty gives innovation an increasingly important role not only for growth but also for survival [31].

The concept of organizational innovation presents a dichotomy: technical Vs administrative [12] [ 15] [ 13]. Technical innovations "pertain to products, services and production process technology; they are related to basic work activities and can concern either product or process" [15, p.560]. Administrative innovations involve organizational structure and administrative process; they are indirectly related to the basic work activities of an organization" [15, p.560]. Trist [64] argues in favor of a balance between the technical system and the social structure of the organization, instead of the adoption of only one of this types of innovation.

### 3.2.2 Organizational Bureaucratization

Organizational bureaucratization is the degree to which procedures are required to be formalized. The contingency theory argues that bureaucratic structures – that rigidly institutionalize previous lessons from prior experience – can improve performance under stable conditions, but more organic structures are necessary in turbulent conditions [43] [ 52]. Either way, it seems reasonable to expect that the degree of bureaucratization of an organization developing e-marketing will affect performance.

### 3.2.3 Organizational Centralization

Centralization refers to the degree in which authority to take decisions concentrates at the highest levels of the organization [22]. There are two schools of thought about the impact of centralization on marketing strategy making. One traditional school argues that centralization leads to a better strategy making, suggesting that in centralized organizations the planning processes use specialized instruments, techniques and personnel [34]. This school also suggests that centralization diminishes the political activity, promoting the rational development of strategy. In contrast, another school defends that centralization is associated with more political activity [25]. From this perspective, centralization imposes time limits to senior decision makers, which consequently give less emphasis to situation analysis and comprehensive development of strategy making [51].

### 3.2.4 Organizational Formalization

Formalization refers to the degree in which rules, procedures, instructions and communications are written and standardized and the degree in which roles are clearly defined [56]. Previous research suggests that the more formalized the institution, the more the levels of rationality in planning and the more the formal systems, such as analysis and evaluation [28] [ 51]. Formalization can lead to ritualistic planning, with more concern in the development of the document than on a comprehensive action plan [46]. Formalization imposes objective criteria and objective procedures in resource allocation and commitment. Formalization increases information sharing and improves the quality of internal communication [36]. It may lead to less role conflict, less role stress and less role ambiguity among marketing staff [50].

### 3.2.5 Organizational Improvisation

Organizational improvisation is the development of mutually adaptive interactions in which knowledge of the work was developed as the work unfolded. Organizational improvisation includes improvisation by groups, departments and whole organizations [23]. Dougherty [23], described the development of new

products by teams that interacted in ways that did not follow established organizational routines.

### 3.2.6 Innovative Organizational Culture

An innovative culture refers to the complex group of beliefs and ways of doing things that influence the organization's perspective on how innovation and change should be managed. An innovative organizational culture refers to the degree to which there is, in the organization an emphasis on creativity, openness to new ideas, and quick decision making [49]. Previous research suggests that an innovative organizational culture motivates systematic attempts to develop, scrutinize and conciliate divergent perspectives about a strategic option [51]. An innovative organizational culture encourages cross-functional integration because it involves different groups in the decision process [57].

### 3.2.7 Market Orientation (competition orientation + client orientation+ inter-functional coordination)

According to Kohli and Jaworski [38], market orientation "is the organization wide generation of market intelligence pertaining to current and future customer needs, dissemination of the intelligence across departments, and organization wide responsiveness to it". Deshpandé and Farley [21] define market orientation as "the set of cross-functional processes and activities directed at creating and satisfying customers through continuous needs-assessment". Kohli and Jaworski [38] conceptualized market orientation as an organized set of marketing activities. A market orientation, as a corporate culture, characterizes an organization's disposition to deliver superior value to its customers continuously. Scholars of market orientation consider that a market-oriented corporate culture as a significant factor to achieve corporate performance. It has been shown that market orientation, is, in general, positively related with various business performance measures [36][ 58] [61].

Narver and Slater [53] suggested that market orientation consists of three behavioral components, each involved in the collection, dissemination and response to information: customer orientation, competitor orientation and inter-functional coordination, that constitute "the activities of market information acquisition and dissemination and the coordinated creation of customer value".

Customer orientation: under the perspective of the marketing concept - that argues for placing clients' interests first - a customer orientation is one of the most fundamental aspects of organizational culture e.g. [20] [44]. Following the organizational learning theory Huber [35] and Sinkula [60] see customer knowledge process as consisting on three sequential aspects: customer information acquisition, interpretation and integration. Competitor orientation: a focus on client alone can take

the institution to a reactive cycle, instead of proactive, if it does not consider equally the competitors actions [18]. A competitor-oriented company seeks to evaluate its strengths and weaknesses in relation to its main competitors with the objective of maintaining or winning advantage. Competitor knowledge process is the process of information collection about the strengths and weaknesses of competitions, analysis and integration in decision making. Like customer knowledge process, this process involves three behavioral aspects: competitor information acquisition, interpretation and integration. De Geus [19] argues that in the future the only competitive advantage of a company is its ability to know about the competition quicker than its rivals. Inter-functional coordination: Felton [27] insists that for the marketing concept to be implemented, there must be integration of the other organization's functions with marketing. Communication among the various functions of the company help the ability to respond to the client, which is harder to achieve if the various departments work within their routines without a common objective [70].

## 3.3 External Forces

### 3.3.1 Market Turbulence

Market turbulence is the degree of change in the clients composition and in its preferences [36]. The market turbulences are typically generated by the heterogeneity of consumer preferences [33].

Korgaonkar and Wolin [39] studied web users' motivations and concerns in relation to different types of usage. They found out that web users' motivations and concerns correlate significantly with the number of hours per day spent on the Web, the percentage of time spent on the Web for both personal and business purposes, and the user's purchasing behavior. The findings suggest the presence of seven motivations and concerns regarding web use: social escapism, transaction-based security and privacy, information, interactive control, socialization, nontransactional privacy, and economic motivation. Although the study asserts that Web users' behavior varies based on gender, education, income and age, motivations and concerns play a greater role than demographics alone in determining subjects' actions with respect to web usage.

### 3.3.2 Environmental Turbulence

Degree to which there is change in the environment. Previous research underlined the role that the external environment has on the development of strategy and performance [25]. When the environment in which an organization operates experiences a lot of change, the organization has several choices: It can ignore external demands or shocks that suggest the need to change plans and continue with previously planned activities; it can attempt to speed up its planning and

execution cycles so that they remain distinct but happen more quickly [26] or it can move toward an improvisational approach that merges planning and execution processes. Fast-changing environments can destroy the value of existing competencies [65]. Organizational scholars have argued that the increased pace of competition might require organizations to develop an improvisational competency to prosper [6]. Exogenous shocks and demands come along more rapidly than an organization can anticipate, and organizations often respond to such situations by improvising rather than not responding.

### 3.3.3 Technological Turbulence

Technological turbulence is the degree of change associated with new product technologies [30][36][68]. Technology change refers to the speed with which the technology is developed in a market product. On one hand, Day and Wensley [18] and Narver and Slater [53], argue that, when technologies change quickly, it is imperative to the companies to interact with clients because its preferences and needs can provide directions in a product market. On the other hand, Jaworski e Kohli [36] suggest that the importance of information from the client is lower because he knows little about the emergent technologies. In a product market, on which technology changes rapidly, the companies can have urgent needs to collect intelligence, because a close observation of competition gives early warnings about the competition's chance to use opportunities created by an emergent technology, winning competitive advantage in the development of new products.

### 3.3.4 Competitive Intensity

Competitive intensity is the degree of competitive force in a product market. In conditions of intensive competition, collection of information about competition can help the companies to anticipate better the changes in competitor strategies for new products and reduce "market unpredictability". With intensive competition in product advantage and market share became more volatile and neglect competition can damage more the position of the company in the market [18].

## 3.4 E-Marketing Strategy

The question challenging today's entrepreneur is not whether to have a web site but how to become the winner in Internet competition. The strategy chosen by the company is its answer of management to the perceived environment. Afterwards, the company communicates and implements a business strategy by stipulating specific performance goals, criteria and actions [9].

Strategy as a general direction of the company, reflects its response based on information from the

environment [37] and that can explain the magnitude of the relation between performance measures and a specific marketing response from the company (as for example market orientation). Walker and Ruekert [67] argue that strategic orientation, performance in specific dimensions and marketing activities have a contingent relation: the companies choose a type of strategy to obtain excellency in particular dimensions of performance, and execute each strategy by choosing marketing activities.

The current study will operationalize web strategy using four main constructs, in another words, will use the 4Ws: Web-Design, Web-Promotion, Web-Price and Web-CRM (Figure 1).

### 3.4.1 Web-Design

Attitude towards the web site has been researched as an important measure for how well a web site is doing. Chen and Wells [10] found out that entertainment, informativeness and organization profiles of web sites are descriptive dimensions correlated with attitude towards the site. When web sites are intended primarily to convey information, users put more weight on Informativeness and Organization, and less on Entertainment. Taken together, these dimensions complement each other and offer some clues on how to improve web site design and presentation. A good web site is one that delivers relevant and well-organized information in an engaging manner.

### 3.4.2 Web-Promotion

Stevenson et al. [62] have researched on the type of background that is most appropriate for positively affecting advertising effectiveness as measured by several common attitude measures, namely attitude towards the ad, attitude towards the brand, attention to the commercial, purchase intention, and attitude towards the web site. Their findings suggest that simpler web page backgrounds are more effective than more complex ones. Bruner and Kumar [7] further explored the advertising hierarchy of effects and its antecedents in the context of the web. Web experience was found to play an important role along with web page complexity and interestingness on attitude towards the web site, which in turn had significant effects on the web advertising hierarchy of effects.

### 3.4.3 Web-Price

The advent of the Internet as a new medium for buyer-seller interaction is changing the issue of price for both customers and suppliers in an unprecedented way. On the one hand, there are Internet dynamics that flatten the customer value pyramid because of technology that facilitates customer search, customer control over transactions and a return to one-on-one negotiation. On the other hand, firms may create customer switching

barriers, differentiate on other dimensions of the purchase decision and reduce transaction costs [55]. The fundamental value of the Internet lies not in lowering prices or making them consistent but in optimizing them [2].

#### **3.4.4 Web-CRM**

The Web can be used to establish direct marketing channels between firms and consumers [42].

Through data mining tools, it is possible to make use of the personal information on a visitor's web site and identify his or her interests and needs. Based on such understanding, firms can send e-mail messages and offer service packages especially designed for a potential customer, based on the marketer's assessment of the individual's interests.

Because of increased competition among actors offering their products and services on the Internet, generating revisits to companies's web sites has become a major challenge for many companies. In order to generate revisits, substantial amounts of resources are used in efforts to develop superior web sites that attract customers [63]. By structuring one's thinking about a firm's relationship with its customers, companies can identify their strengths and highlight areas in need of improvement [54].

### **3.5 Performance**

#### **3.5.1 Firm Performance**

Firm performance is a well-established measurement in the marketing literature. We will measure it through sales volume, profitability and market share for the current period (current firm performance), and perceived satisfaction with these measures when considering the previous year (past firm performance).

#### **3.5.2 E-Performance**

Although many e-commerce companies collect cost and usage data about their Web sites, few of them understand in any detail how well such information measures their sites' performance or how this performance compares with that of competing sites. However, since year 2000 investors have been insisting, if not on profits, at least on objective measures of a site's success in attracting, converting and retaining customers.

A key concern of this study is related with the conceptualization and measurement of performance. Overall the literature suggests that it is required a multidimensional scale. One approach that is increasingly relied upon is the aggregation of various performance measures into a single measure of performance. We incorporate this approach here by considering web site performance evaluation [8].

## **4 Implications**

### **4.1 Implications for Theory**

Considering the rapid growth of e-commerce in our marketplace, it seems to be a need to assess what is really happening in the managerial world. We believe that marketing researchers generally are ignoring a significant part of the marketing-performance phenomenon. Research should consider two sets of relationships: Performance→E-Marketing effects and E-Marketing→Performance effects. In other words research, has to identify if e-marketing strategy is not only an antecedent, but also an outcome, of performance. Furthermore, the existing research in marketing, which has focused exclusively on the study of direct relationships, has been inconclusive. In addition to the analysis of the direct relationships, future research may empirically test the conceptual framework presented here. This will add to previous research by showing how the contingent forces (i.e. internal and external forces) affect performance directly and indirectly, through their influence on the definition of the e-marketing strategies.

### **4.2 Implications for Public Policy and Management**

From the point of view of both firms and most national governments, the use of the Internet is extremely attractive because it reduces the firms' dependency on the domestic market, allows increase production through sales to foreign markets and consequently creates employment and enhances societal prosperity.

Public policy makers may play an active role in promoting the e-commerce activity, namely by providing support to business training. Thus, from the perspective of public policy makers, the following questions emerge: how can public policy makers help firms to compete in the electronic age and help them firms improve performance? What kind of support should be provided?

The present research seeks to identify effective e-marketing practices in order to help public policy makers to plan and refine the substance of their support. It is expected to help public policy makers to have a better notion of where to apply resources vis-à-vis e-commerce development.

In sum, the conceptual model presented in Figure 1 helps to systematize the e-marketing phenomenon and is expected to support public policy makers and managers in developing effective e-marketing strategies.

## References

- [1] Audia, Pino G., Edwin Locke, and Ken Smith, "The Paradox of Success: An Archival and a Laboratory Study of Strategic Persistence Following Radical Environmental Change", *Academy of Management Journal*, 2000, 43 (5): 837-53.
- [2] Baker, W; M Marn; C Zawada "Price Smarter on the Net", *Harvard Business Review* 2001, (February): 2-7.
- [3] Bonoma, T. and B. Clark, *Marketing Performance Assessment*. Boston, Mass.: Harvard Business School Press, 1988.
- [4] Bontis, N. and A. De Castro "The First World Congress on the Management of Electronic Commerce: Review and Commentary", *Internet Research*, 2000, 10 (5): 365-373.
- [5] Boulding, K. "General Systems Theory - The Skeleton of Science," *Management Science*, 1956, 2, 197-208.
- [6] Brown, Shona and Kathleen Eisenhardt, "Product Development: Past Research, Present Findings and Future Directions," *Academy of Management Review*, 1995, 20 (Apr) 343-78.
- [7] Bruner, G and A Kumar "Web Commercials and Advertising Hierarchy of Effects," *Journal of Advertising Research* 2000, (Apr): 35-42.
- [8] Chakraborty, G., V. Lala, and W. David "Important Factors in Business to Business Web Site Evaluation: A Scale Development Study," In M. Evans and L. Sheer (eds.) *Proceedings of the American Marketing Association Winter Conference*, 2002.
- [9] Chandler, A. "Strategy and Structure, Environment, and Performance - The Role of Strategic Choice", *Sociology*, 1962, 6 (Jan), 1-22.
- [10] Chen, Q. and W. Wells "Attitude Towards the Site", *Journal of Advertising Research*, 1999 (Oct): 27-37.
- [11] Cyert, R. and J. March *A Behavioral Theory of the Firm*. Englewood Cliffs, N.J.: Prentice-Hall, 1963.
- [12] Daft, R. "A Dual-Core Model of Organizational Innovation," *Academy of Management Journal*, 1982, 21 (2), 193-210.
- [13] Dalton, G. *The Distribution of Authority in Formal Organization*. Boston: Harvard University, Division of Research, 1986.
- [14] Damanpour, Fariborz "The Adoption of Technological, Administrative and Ancillary Innovations: Impact of Organizational Factors," *Journal of Management*, 1987, 13 (4), 675-88.
- [15] Damanpour, Fariborz "Organizational Innovation: A Meta-Analysis of Effects of Det", *Academy of Management Journal*, 1991, 34 (3), 555-590.
- [16] Damanpour, Fariborz and William Evan, "Organizational Innovation and Performance: The Problem of Organizational Lag," *Administrative Science Quarterly*, 1984, 29 (3), 392-409.
- [17] Damanpour, Fariborz; Kathryn Szabat, and William Evan "The Relationship Between Types of Innovation and Organizational Performance," *The Journal of Management Studies*, 1989, 26 (6), 587-601.
- [18] Day, George and Robin Wensley "Assessing Advantage: A Framework for Diagnosing Competitive Superiority," *Journal of Marketing*, 1988, 52 (April), 1-20.
- [19] De Geus, Arie "Planning as Learning," *Harvard Business Review*, 1988, 66 (Mar/Apr), 70-74.
- [20] Deshpandé, Rohit and Frederick Webster Jr. "Corporate Culture, Customer Orientation, and Innovativeness in Japanese Firms: A Quadrad Analysis," *Journal of Marketing*, 1993, 57 (January), 23-27.
- [21] Deshpandé, Rohit and John U. Farley "Understanding Market Orientation: A prospectively Designed Meta-Analysis of Three Market Orientation Scales," Working Paper Series Report 96-125, Cambridge, MA: Marketing Science Institute, 1996.
- [22] Dewar, Robert and James Werbel "Universalistic and Contingency Predictions of Employee Satisfaction and Conflict," *Administrative Science Quarterly*, 1979, 24 (Sep), 426-48.
- [23] Dougherty, Deborah "Interpretive Barriers to Successful Product Innovation in Large Firms," *Organization Science*, 1992, 3 (May) 179-202.
- [24] Dutton, J. and R. Duncan "The Creation of Momentum for Change Through the Process of Strategic Issue Diagnosis," *Strategic Management Journal*, 1987, 8, 279-295.
- [25] Eisenhardt, Kathleen "Making Fast Strategic Decisions in High-Velocity Environments," *Academy of Management Journal*, 1989, 32 (Sep), 543-576.
- [26] Eisenhardt, Kathleen and Behnam Tabrizi "Accelerating Adaptive Processes: Product Innovation in the Global Computer Industry," *Administrative Science Quarterly*, 1995, 40 (Mar), 84-110.
- [27] Felton, Arthur "Making the Marketing Concept Work," *Harvard Business Review*, 1959, 37 (Jul/Aug), 55-65.
- [28] Fredrickson, J. "An Exploratory Approach to Measuring Perceptions of Strategic Decision Process Constructs," *Strategic Management Journal*, 1986, 7 (Sep/Oct), 473-83.
- [29] Fredrickson, J. "Effects of Decision Motive and Organizational Performance Level on Strategic Decision Processes," *Academy of Management Journal*, 1985, 28 (4): 821-43.
- [30] Glazer, Rashi and Allen Weiss "Marketing in Turbulent Environment: Strategic Implications of Knowledge as an Asset," *Journal of Marketing*, 1993, 55 (Oct), 1-19.
- [31] Grønhaug, Kjell and Geir Kaufmann *Innovation: A Cross-Disciplinary Perspective*. Oslo, Norway: Norwegian University Press, 1988.
- [32] Hair Jr., J., R. Anderson, R. Tatham, and W. Black *Multivariate Data Analysis*. New York: Prentice Hall International, 1998.
- [33] Han, Jin, Namwoon Kim, Rajendra Srivastava "Market Orientation and Organizational Performance: Is Innovation a Missing Link?," *Journal of Marketing*, 1998, 62 (4), 30-45.
- [34] Hofer, C. and Dan Schendel *Strategy Formulation: Analytical Concepts*. St. Paul, MN: West Publishing Co, 1978.
- [35] Huber, George "Organizational Learning: The Contributing Processes and the Literatures," *Organization Science*, 1991, 2 (Feb), 88-115.
- [36] Jaworski, Bernard and Ajay Kohli "Market Orientation: Antecedents and Consequences," *Journal of Marketing*, 1993, 57 (Jul) 53-71.
- [37] Jennings, Devereaux and Paul Zandbergen "Ecologically Sustainable Organizations: An Institutional Approach," *Academy of Management Review*, 1995, 20 (4), 1015-1052.
- [38] Kohli, Ajay and Bernard Jaworski "Market Orientation: The Construct, Research Propositions, and Managerial Implications," *Journal of Marketing*, 1990, 54 (Apr), 1-18.

- [39] Korgaonkar, P and Wolin L. "A Multivariate Analysis of Web Usage," *Journal of Advertising Research*, 1999, 39 (Mar-Apr), 53-68.
- [40] Lages, Luis Filipe, and David Montgomery "The Effects of Prior Export Performance on Firm's Commitment to Exporting and Marketing Strategy Adaptation to the Foreign Market: Evidence from Small and Medium-Sized Exporters", Research Paper # 1701, Stanford University, Graduate School of Business, 2001.
- [41] Lages, Luis Filipe "A Conceptual Framework of the Determinants of Export Performance: Reorganizing Key Variables and Shifting Contingencies in Export Marketing," *Journal of Global Marketing*, 2000, 13 (3): 29-51.
- [42] Lau, K, K Lee, P Lam, and Y Ho "Web Site Marketing for the Travel and Tourism Industry," *Cornell Hotel and Restaurant Administration Quarterly*, 2001, 42 (Dec), 55-62.
- [43] Lawrence, Paul and J. Lorsch *Organization and Environment: Managing Differentiation and Integration*. Boston: Division of Research Graduate School Business Administration, Harvard University, 1967.
- [44] Lawton, Leigh and A. Parasuraman "The Impact of the Marketing Concept on New Product Planning," *Journal of Marketing*, 1980, 44 (Win), 19-25.
- [45] Loiacono, E., R Watson and D. Goodhue "WebQual: A Measure of Web Site Quality". In M. Evans and L. Sheer (eds.) *Proceedings of the American Marketing Association Winter Conference: 2002*, 432-438.
- [46] Lyles, Marjorie and R. Lenz "Managing the Planning Process: A Field Study of the Human Side of Planning," *Strategic Management Journal*, 1982, 3 (Jan/Feb), 105-118
- [47] March, James, and H. Simon *Organizations*. New York: John Wiley & Sons, 1958.
- [48] March, James, and Robert Sutton "Organizational Performance as a Dependent Variable". *Organization Science*, 1997, 8 (6): 698-706.
- [49] Menon, Anil and P. Varadarajan "A Model of Marketing Knowledge Use Within Firms," *Journal of Marketing*, 1992, 56 (Oct), 53-71.
- [50] Michaels, Ronald, William Cron, Alan Dubinsky, and Erich Joachimsthaler "The Influence of Formalization on the Organizational Commitment and Work Alienation of Salespeople and Industrial Buyers," *Journal of Marketing Research*, 1988, 25 (Nov) 376-383.
- [51] Miller, Danny "The Structural and Environmental Correlates of Business Strategy," *Strategic Management Journal*, 1987, 8 (Jan/Feb), 55-76.
- [52] Mintzberg, Henry *The Structuring of Organizations*, Englewood Cliffs, NJ: Prentice-Hall, 1979.
- [53] Narver, John and Stanley Slater "The Effect of a Market Orientation on Business Profitability," *Journal of Marketing*, 1990, 54 (Oct) 20-35.
- [54] Picolli, G., B. Spalding, and B. Ives "The Customer Service Lifecycle: A Framework for Improving Customer Service Through Information Technology," *Cornell Hotel and Restaurant Administration Quarterly*, 2001, 42 (3): 38-45.
- [55] Pitt, L, P Berthon, R Watson, and M Ewing "Pricing Strategy and the Net," *Business Horizons*, 2001, (Mar/Apr): 45-54.
- [56] Pugh, Derek; David Hickson, C. Hinnings, and C. Turner "Dimensions of Organizational Structure," *Administrative Science Quarterly*, 1968, 13 (Jun), 65-105.
- [57] Ruekert, Robert W and Orville Walker Jr "Marketing's Interaction with Other Functional Units: A Conceptual Framework and Empirical Evidence," *Journal of Marketing*, 1987, 51 (Jan) 1-19.
- [58] Selnes, Fred, Bernard Jaworski, and Ajay Kohli "Market Orientation in US and Scandinavian Companies: A Cross-Cultural Study". *Marketing Science Institute Working Paper no 97-107*. Cambridge, MA: Marketing Science Institute, 1997.
- [59] Simon, H. *Administrative Behavior*. New York: McMillan, 1957.
- [60] Sinkula, James "Market Information Processing and Organizational Learning," *Journal of Marketing*, 1994, 58 (Jan), 35-45.
- [61] Slater, Stanley and John Narver "Does Competitive Environment Moderate the Market Orientation-Performance Relationship?" *Journal of Marketing*, 1994, 58 (Jan), 46-55.
- [62] Stevenson, Julie, Gordon Bruner II, Anand Kumar "Webpage Background Viewer Attitudes," *Journal of Advertising Research*, 2000, 40 (Jan): 29-34.
- [63] Supphellen, M and H Nysveen "Drivers of Intention to Revisit the Web Sites of Well-Known Companies: The Role of Corporate Brand Loyalty," *International Journal of Market Research*, 2001, 43 (3): 341-352.
- [64] Trist, L. *The Evolution of Socio-Technical Systems as a Conceptual Framework and as an Action Research Program in Perspectives on Organization Design and Behaviour*. A. H. Van de Ven and W. F. Joyce (Eds). N.Y.: John Wiley and Sons, 1981.
- [65] Tushman, Michael and Philip Anderson "Technological Discontinuities and Organizational Environments," *Administrative Science Quarterly*, 1986, 31 (Sep), 439-65.
- [66] Von Bertalanffy, L. "General System Theory: A New Approach to Unity of Science", *Human Biology*, 1951, 23 (Dec), 303-61.
- [67] Walker, Orville and Ruekert, Robert "Marketing's Role in the Implementation of Business Strategies: A Critical Review and Conceptual Framework," *Journal of Marketing*, 1987, 51 (Jul), 15-33.
- [68] Weiss, Allen and Jan B. Heide "The Nature of Organizational Search in High Technology Markets," *Journal of Marketing Research*, 1993, 30 (May), 220-233.
- [69] Wyner, G. "Learn an Earn Through Testing on the Internet," *Marketing Research*, 2000, 12 (3): 37-38.
- [70] Zaltman, Gerald, Robert Duncan, and J. Holbek *Innovations and Organizations*. New York: John Wiley and Sons, 1973.
- [71] Zeithaml, V. A.; P. Varadarajan, and C. P. Zeithaml "The Contingency Approach: Its Foundations and Relevance Theory Building and Research in Marketing", *European Journal of Marketing*, 1988, 22(6), 37-64.

# Consumer Perceptions of Traditional and Electronic Markets

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## Abstract

The objective of this study is to identify factors that are significantly associated with consumer in electronic or traditional market. The study uses consumer cost differences which are product price, product quality, after-sales service, product refund or exchange, variety and assortment of product offerings, time saving on buying product, convenience to buy product, distribution cost, sufficient law to protect consumer, security of payment by credit card to differentiate consumers from traditional and electronic markets. The result indicates that four of ten factors (product price, product quality, product refund or exchange, and time saving on buying product) can classify consumers in the two markets. Internet buyers' characteristics and behaviour are discussed.

## 1. Introduction

Internet has become an important medium for organizations desiring to market their products and services via electronic market. Although many organizations have claimed that Internet involves in their business success, little research has been conducted to prove the success of electronic market. Online shopping also has some limitations (i.e., the lack of variety of products, disappointing customer service, and wariness about unknown Internet retailers). Consumers may diffuse online shopping differently. Some consumers may still prefer traditional markets (i.e., retail stores) to electronic markets or vice versa. In addition, the Internet's effects on consumer behavior are unpredictable.

The electronic market in Thailand is still in its infancy. Survey on factors affecting the Internet usage by Chumchuan [2] revealed that Thai consumers are aware of sufficient law to protect transaction processed via Internet. In addition, the consumers are not confident in the quality of product/service bought from Internet and in the security of payment system [16]. Even though some Thai consumers are anxiety and unbelief in the electronic market, the others buy product on Internet. Therefore, additional research is needed to understand which factors (such as types of products,

costs relevant to traditional or electronic markets, and services from vendor etc.) are significantly associated with consumer perceptions of traditional and electronic markets. These factors can also be used to create model for predicting group membership (traditional versus electronic markets) from a set of predictors. The main purpose of this research is to investigate factors that influence individuals' decision to shop by either electronic or traditional markets.

## 2. Black Ground

Every buyer is engaged in continuous decision process which consists of five stages: need recognition, information search, evaluation of alternatives, purchase decision, and postpurchase behavior [7][8][1]. Many of these stages involve costs such as searching for sellers, delivering and monitoring product/service. As different marketing channels have some differently associated costs, a consumer normally compares relative advantage in each potential market. The relative advantage is often expressed in savings in time and effort, and cost reduction [15]. Therefore, a reasonable consumer usually attempts to minimize the relative costs involving the decision process [3]. Given the two types of marketing channels (traditional and electronic markets), the six costs associated with these markets include product price, search costs, risk costs, distribution costs, sales tax, and market costs [13]. However, as sales tax in Thailand is equal in each marketing channels, this study does not include sales tax in consideration.

### 2.1 Product Price

Product price is the sum of the production costs, coordination costs, and profits added to the product or service [13]. The benefits of electronic markets to both buyers and sellers are low cost and improved efficiencies [1]. The electronic marketing can reduce costs of order processing, inventory handling, delivery, and trade promotion because buyers deal directly with sellers. In addition, communicating electronically often costs less than communicating on paper through the mail.

## 2.2 Search Costs

Search costs are the time, effort, and money involved in obtaining and comparing the available brands and features of product demanded from various sellers [13]. Generally, a consumer will search on product price, product quality, and product features until he/she reaches the final purchase decision [13][1]. The product quality means the ability of the product to perform its functions, free from defects, and consistency in delivering a targeted level of performance. The electronic marketing provides benefits to buyer in term of convenience which, in turn, reduces buyers' search costs. The buyers do not have to go to various stores to find and examine products. In addition, the buyers can access to an abundance of comparative prices of competitive stores, products, or services that fit their needs from any location.

## 2.3 Risk Costs

Risk costs mean the costs involved economic, social, performance, personal, and privacy risks [13] [17]. The buyer decision process does not end when the product is bought. After purchasing the product, the consumer will be engage in postpurchase behaviour which is satisfaction or dissatisfaction. Normally, the buyer is disappointed when the delivered product fails to meet specifications. As the Internet buyers cannot touch or examine the products during evaluation stages, and they usually receive purchases via mail delivery, the buyer will require favourable terms such as warranty or replacement of products without difficulty and within a short time [3]. In addition, there are some risks associated with ensuring security of credit card transaction on the electronic market because information transmitted over Internet may be intercepted and misused. Therefore, the perception of security risk can be attributed to separate consumers from electronic to traditional markets.

## 2.4 Distribution Costs

Distribution costs refer to the costs involving the physical exchange of products or services from seller to the buyer [13][9]. The distribution costs are associated with types of products and services purchased over the Internet. The digital products such as electronic books and software can be delivered digitally and be used by the consumer straightaway. Sending the digital products or services online reduce the distribution costs. However, the distribution costs for tangible products are higher in electronic market than in traditional market because there is the need for the consumer to pay distribution costs to receive the product.

## 2.5 Market Costs

Market costs are the costs associated with participating in a market [13][3]. These costs include fee paid by buyers to access to the Internet and the costs paid to the firms that operate the electronic market. The

traditional market, however, are assumed these costs differently. The cost for traditional market is in the form of transportation to the shop.

This study applied the work by Strader and Shaw [13] on consumer cost difference for traditional and Internet markets. The costs associated with Thai consumers are examined. Thus, the aim of this paper is to provide the empirical answer to the following research question.

Research question : What are the factors that are significantly classified consumers into electronic or traditional market?

## 3. Research Methodology

### 3.1 Sample and Procedure

Five hundred questionnaires were distributed to participants in three main cities in Thailand (Bangkok, Chiang Mai, and Khon Kaen). Reason for limiting the study to the above participants was that participants in the main cities normally understand electronic market than participants in the small cities. In addition, the participants were universities' students and office staffs who have knowledge in e-commerce. The returned and usable results for further statistical analysis were 299 questionnaires. These questionnaires were divided into two groups, Internet buyers and non-Internet buyers. The groups were separated in term of whether participants used to purchase the products from Internet. The usable results were 73 questionnaires for Internet buyers group and 226 questionnaires for non-Internet buyers group. In addition, the questionnaires in two groups were split into analysis and holdout (validation) samples. The analysis sample was used to develop the discriminant function. Meanwhile, the holdout sample was used to test the discriminant function. This study used a 75-25 split to divide the sample into analysis and holdout groups. Moreover, the smallest group size must exceed the number of independent variables to ensure the minimum impact of sample size on the estimation of the discriminant function [4]. Finally, the purchase group contained 55 observations for analysis and 18 observations for validation. Meanwhile, the not purchase group was divided into 168 observations for analysis and 58 observations for validation. Sample sizes were quite different in the Internet buyers and non-Internet buyers groups in analysis and holdout data. However, with ratios of 1:3.05 in analysis group and 1:3.22 in holdout group, the discrepancy in sample sizes does not invalidate use of discriminant analysis [14].

The evaluation of assumptions of linearity, normality, multicollinearity or singularity, and homogeneity of variance-covariance matrices revealed no threat to multivariate analysis. The collected information was then analysed by using discriminant analysis with stepwise method. Ten variables were used as predictors of membership in two groups. The ten variables which identified Internet buyers from non-

Internet buyers were product price, product quality, after-sales service, product refund or exchange, variety and assortment of product offerings, time saving on buying product, convenience to buy product, distribution cost, sufficient law to protect consumer, security of payment by credit card.

### 3.2 Results

The results suggests that a discriminant function is significant at  $\chi^2(5) = 108.120$  with p value  $< 0.01$ . The discriminant function accounts for 81.60 percent of grouped cases (see table 2). The discriminant loadings, as seen in table 1, suggests that the best predictors for distinguishing between Internet buyers and non-Internet buyers were product price, product quality, product refund or exchange, and time saving on buying product.

Of the four variables in the discriminant function, product quality discriminates the most while time saving on buying product discriminated the least. Distribution cost is not included in the model, even though it showed statistical significance. The discriminant loading of this variable is less than an accepted level ( $\pm .30$ ). After distribution cost was deleted from the analysis, the group means (centroids) of the discriminant function is 1.339 for Internet buyers and -0.438 for non-Internet buyers. The results give the following estimated discriminant function.

$$D = -5.156 + 0.439 \text{ Product price} + 0.467 \text{ Product quality} + 0.364 \text{ Product refund or exchange} + 0.374 \text{ Time saving on buying product} \quad (1)$$

**Table 1 Summary of interpretive measures for consumer perceptions of traditional and electronic markets**

Dependent variables	Unstandardized coefficients	Discriminant loadings		F statistic	
	Value	Value	Rank	Value	Significance
Product price	.449	.582	2	34.618	.000
Product quality	.460	.642	1	54.466	.000
After-sales service	NI	.348	5	NI	
Product refund or exchange	.438	.464	3	30.067	.000
Variety and assortment of product offerings	NI	.290	6	NI	
Time saving on buying product	.371	.460	4	40.311	.000
Convenience to buy product	NI	-.119	10	NI	
Distribution cost	-.284	-.016	9	25.979	.000
Sufficient law to protect consumer	NI	.153	7	NI	
Security of payment by credit card	NI	.078	8	NI	
Constant	-4.644				

NI means this variable is not included in the stepwise solution.

The holdout samples have been used to examine the predictive accuracy of the discriminant function. The cutting score (-0.0002) is used as the criterion against each observation's discriminant Z score to determine group member for the observation. The classification matrices for consumer perceptions of traditional and electronic markets show in table 2. The analysis samples (with 81.60 percent classification accuracy) have higher prediction accuracy than the holdout samples (with 65.75 percent classification accuracy). As the discriminant function would classify a subject in the smaller group where the sample sizes are unequal, the prediction accuracy rate was compared with the two chance measures (proportional chance criterion or  $C_{pro}$

and Press's Q statistic) [4]. The purpose of comparison is to determine whether the prediction accuracy rate is in the acceptable level and the classification accuracy of group membership is not occurred by chance. The results show that the prediction accuracy (81.60 percent) is higher than the proportional chance criterion (42.19 percent) and the maximum chance criterion (61.89 percent). In addition, the values of Press's Q of analysis sample and holdout sample (89.15 and 5.26) exceed the critical value of 3.841 ( $\chi^2(1)$ ,  $p = 0.05$ ). Therefore, the predictions are significantly better than chance.

**Table 2 Classification matrices for consumer perceptions of traditional and electronic markets**

Actual group	Number of cases	Predicted group membership	
		Internet buyers	Non-Internet buyers
Analysis sample <sup>a</sup> :			
Internet buyers	55	44 80.00%	11 20.00%
Non-Internet buyers	168	30 17.90%	138 82.10%
Number of cases		74	149
Holdout sample <sup>b</sup> :			
Internet buyers	18	13 72.22%	5 27.78%
Non-Internet buyers	58	23 39.66%	35 60.34%
Number of cases		36	40

<sup>a</sup> Percent of grouped cases correctly classified is 81.60%.

<sup>b</sup> Percent of grouped cases correctly classified is 65.75%.

Table 3 shows the correctly classified and the misclassified cases from the analysis and holdout samples. Data in this table is used to identify specific differences on the independent variables that might identify either new variable to be added or common characteristics that should be considered. The eighteen cases misclassified in the Internet buyers group have significant differences on two of the four variables in the discriminant function. In addition, most variables, which were not included in the discriminant function, demonstrate significant differences. The non-Internet buyers group, however, shows a similar pattern, although with different variables. The statistically significant differences of some variables (product refund or exchange, time saving on buying product and variables not included in discriminant function) suggest that other variables would identify characteristic that identifies group membership.

Moreover, the Internet buyers' demographic characteristics, economic factors, and behaviour

towards the purchasing of products or services through the internet are summarized (see Table 4). In this study, the Internet buyers are younger. There are 36.5 percent of Internet buyers aged 20-26 years old; 28.4 percent of Internet buyers aged 27-33 years old; and 17.6 percent of Internet buyers aged 34-40 years old. The Internet buyers are more male (75.7 percent) than female (24.3 percent). A total of 75.7 percent of Internet buyers are single. In addition, most of Internet buyers are college graduates. They obtain a bachelor degree (51.4 percent) and a master degree (27.0 percent). The mean income of Internet buyers is 20,000 baht (around 476 US\$). Moreover, the Internet buyers spend a little time searching for the information before making purchase decision. The popular goods were publications and computer software. In addition, Thai Internet buyers prefer products with well-known brands. The product price, however, should be 10% cheaper than those available in shops. Usually, the products are paid by credit card.

**Table 3 Profiling correctly classified and misclassified observations in consumer perceptions of traditional and electronic markets**

Dependent variables	Mean scores			t test	
	Correctly classified	Misclassified	Difference	t value	Significance
<b>Internet buyers:</b>					
	(N = 55)	(N = 18)			
Product price <sup>a</sup>	4.00	2.29	1.71	3.667	.170
Product quality <sup>a</sup>	4.36	2.43	1.94	3.510	.177
After-sales service	4.18	2.86	1.32	5.314	.118
Product refund or exchange <sup>a</sup>	3.36	2.71	0.65	9.360	.068
Variety and assortment of product offerings	3.55	3.29	0.26	26.300	.024
Time saving on buying product <sup>a</sup>	4.18	3.57	0.61	12.702	.050
Convenience to buy product	4.91	5.29	-0.38	27.069	.024
Distribution cost	3.00	2.29	0.71	7.400	.086
Sufficient law to protect consumer	3.27	3.00	0.27	23.000	.028
Security of payment by credit card	4.00	3.57	0.43	17.667	.036
<b>Non-Internet buyers:</b>					
	(N = 168)	(N = 58)			
Product price <sup>a</sup>	2.61	3.73	-1.12	5.679	.111
Product quality <sup>a</sup>	2.58	3.36	-0.78	7.621	.083
After-sales service	2.75	3.23	-0.48	12.524	.051
Product refund or exchange <sup>a</sup>	2.47	2.86	-0.39	13.632	.047
Variety and assortment of product offerings	3.33	3.41	-0.08	89.000	.007
Time saving on buying product <sup>a</sup>	2.56	3.91	-1.35	4.776	.131
Convenience to buy product	4.86	4.23	0.63	14.339	.044
Distribution cost	2.11	2.59	-0.48	9.800	.065
Sufficient law to protect consumer	2.39	2.50	-0.11	44.000	.014
Security of payment by credit card	3.69	3.36	0.33	21.336	.030

<sup>a</sup> Variables included in the discriminant function.

**Table 4 Information on buying product/service on traditional and electronic markets**

Items	Response	Percentage
<b>Purchase product/service via Internet market:</b>		
1. Average number of Internet web sites searching for product/service before making purchase decision	1-3 web sites	41.9
2. Time used to search product/service before making purchase decision	Less than 2 hours	48.6
3. Product/service buying from internet	Book, article or magazine, and software	54.1
3.1 First ranking of high purchase		
3.2 Second ranking of high purchase	Computer and peripheral	17.6
3.3 Third ranking of high purchase	Toy and recreation	14.9
4. Consideration of product brand	Consider	81.1
5. Product price	Should less than buying product from traditional market 10%	33.8
6. Method of payment	Credit card	66.2
7. Method of product delivery	Mail	68.9
8. Satisfying product	Satisfy	91.9
9. Product delivery time	3-7 days	48.6
<b>Purchase product/service via traditional market:</b>		
1. Average number of places searching for product/service before making purchase decision	1-3 places	55.4
2. Time used to search product/service before making purchase decision	Less than 2 hours	41.9
3. Consideration of product brand	Consider	75.7

#### 4. Discussion

The results provide some preliminary answers to the main purpose of this paper. The findings suggest that product price and quality influence consumers. If the savings in transactions costs can be passed on to consumers in the forms of less price without compromising quality, it can be positive influence on consumers to buy products in electronic market. In addition, the result indicates that the Internet buyers in Thailand usually buy famous brands because the buyers are confident of the quality assurance of those products.

Moreover, tangibility of products is also the most important factors for Thai consumers. The survey by Wongpinunwatana and Achakulwisut [18] on the adoption of e-commerce of Small to Medium Enterprises (SME) in Thailand indicates that Thai consumers want to inspect products before making purchase decision. As the Internet buyers will visualize products from Internet, the buyers, therefore, require warranty on product refund or exchange in case of delivery products fails to meet their requirements [11]. The on decision to buy products in both marketing

channels, this factor is not indicate high influence on purchase decision. Income of Internet buyers in Thailand is quite low comparing to buyers from other developed countries. Therefore, these buyers will buy products with low cost. The frequently purchased products from Internet are books, articles or magazines, and computer software. Because the Internet buyers can download the previous purchased products from Internet, they do not consider much on the distribution costs. For computer software, Thai consumers will always look for freeware.

However, the factors of after-sales service, variety and assortment of product offerings, convenience to buy product, sufficient law to protect consumer, security of payment by credit card cannot use to identify Internet buyers from non-Internet buyers in Thailand. Several reasons can be used to explain these results. First, intangible products (i.e. books, articles or magazines, and computer software) are not required after-sales support or the warranty and variety of products. Second, many Internet buyers are college students and office staffs. Therefore, Internet access is essentially free for these consumers with access through school or work. If the consumers access the Internet from home, they have to pay for local telephone and Internet access charges. These charges, however, is quite low in Thailand. In addition, they spend less time on Internet and visit less web site before they make purchase decision. Therefore, the amount of participating costs in Internet market is quite equal to the amount of participating costs in traditional market which is costless. Third, contrary to expectations, Internet buyers do not indicate the awareness of security risk of credit card information transmitted over the Internet. The reason could be due to widely use of credit card in both marketing channels and trust with security of payment.

As the percentage of Internet buyers in this study (24.41%) is lower than the percentage of non-Internet buyers (75.59%). Consistent with this result, Ratpol [10] found that Thai consumers are likely to buy products from traditional market. As Internet is still new for Thai consumers, the sellers who want to use Internet as electronic market may have to consider using Internet as information provider.

## 5. Conclusion

In summary, the results from this study indicate that Internet and non-Internet buyers can be differentiated by product price, product quality, product refund or exchange, and time saving on buying product. This finding would be reasonable starting points for understanding types of transaction costs underlining consumers in both marketing channels (electronic and traditional markets) in Thailand. In addition, the organizations, which want to market their products via Internet, can use these results to understand their consumer cost differences for traditional and Internet

markets for an effective launch of this new marketing channel. There are a number of limitations in this study. First, participants in three main cities in Thailand may not be suitable representatives for the whole population. The other samples from other main cities such as Phuket city should be attempted. Second, electronic market in Thailand is still at the infant stage. This market is still in a period of learning. Thai people may not familiar with this new Internet technology. Therefore, information collected for analysis may be restricted.

Future research could be conducted by expanding sample to other cities. In addition, the study should include Thai culture factor. The need to understand how country's culture affects the success of business on the Internet must be considered [5][6][12][3]. The impact of culture has been an ongoing concern in electronic commerce research.

## References

- [1] Armstrong, G. & Kotler, P. *Marketing: An Introduction* (Fifth Edition), Prentice-Hall, 2000.
- [2] Chumchuan, S. *Internet behaviour and adoption*, Unpublished Master thesis, Business School, Thammasat University, Thailand, 1998.
- [3] Gattiker, U. E., Perlusz, S. & Bohmann, K. "Using the Internet for B2B activities: a review and future directions for research," *International Research: Electronic Networking Applications and Policy*, 2000, 10(2), 126-140.
- [4] Hair, J. F., Anderson, R. E., Tatham, R. L. & Black, W. C. *Multivariate Data Analysis* (Fifth Edition), Prentice-Hall, 1998.
- [5] Hofstede, G. "Business Cultures," *UNESCO Courier*, 1994, 47(4), 12-16.
- [6] Johnston, K. & Johal, P. "The Internet as a virtual cultural region: are extant cultural classification schemes appropriate?," *International Research: Electronic Networking Applications and Policy*, 1999, 9(3), 178-186.
- [7] Kalakota, R. & Whinston, A. B. *Electronic commerce: a manager's guide*, Addison Wesley Longman, 1997.
- [8] Kotler, P. *Marketing Management: Analysis, Planning, Implementation, and Control* (Ninth Edition), Prentice-Hall, 1997.
- [9] Phau, I. & Poon, S. M. "Factors influencing the types of products and service purchased over the Internet," *Internet Research: Electronic Networking Applications and Policy*, 2000, 10(2), 102-113.
- [10] Ratapol, W., Piya, T., & Suthee, W. *Factors influencing the types of computer or peripheral purchased over the Internet*, Unpublished Master thesis, Business School, Thammasat, 1999.
- [11] Resarch center. "Consumer behavior in buying personnel computer," *Siam Commercial Bank*, 1996, July-Sep.
- [12] Steenkamp, J. & Hofstede, F. "A Cross-National Investigation into the Individual and National Cultural Antecedents of Consumer Innovativeness," *Journal of Marketing*, 1999, 63(2), 55-69.
- [13] Strader, T. J. & Shaw, M. J. "Consumer cost differences for traditional and Internet markets," *International Research: Electronic Networking Applications and Policy*, 1999, 9(2), 82-92.
- [14] Tabachnick, B. G. & Fidell, L. S. *Using Multivariate Statistic* (Third Edition), Harpen Collin Publishers, 1996.

- [15] Teo, T. S. H., Tan, M. & Buk, W. K. "A Contingency Model of Internet Adoption in Singapore," *International Journal of Electronic Commerce*, 1997, 2(2), 95-118.
- [16] Tungkitvanit, S. "Status of e-commerce in Thailand," <http://www.pantip.net/tech/papers>, 1999, May.
- [17] Vijayarathy, L. R. & Jones, J. M. "Print and Internet catalog shopping: assessing attitudes and intentions,"

*International Research: Electronic Networking Applications and Policy*, 2000, 10(3), 191-202.

- [18] Wongpinunwatana, N. & Achakulwisut, A. "A Conceptual Model of E-Commerce Adoption of Small to Medium Enterprises (SME) in Bangkok and Metropolitan," *ABC 2000 Conference*, Bangkok, 2000, 19-20 October.

# E-Government Deployment for the 21<sup>st</sup> Century

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## Abstract

E-Government leverages technology, specifically the Internet, to simplify the delivery of government services. Furthermore, e-Government improves the business of government by making government more efficient and convenient for the customers. Activities performed through e-Government can be in the nature of transactions, information, or education, to name a few.

## 1. Introduction

Electronic service delivery offers huge opportunities to improve public services for the benefit of citizens; more convenient, more joined-up, more responsive and more personalized. It is going to transform the way the public sector does business, in many cases replacing traditional channels for doing business with more efficient and effective electronic channels.

### 1.1 Value of E-Government

Government provides many opportunities to improve the quality service to the citizen. Citizens should be able to get service or information in minutes or hours, versus today's standard of days or weeks. Citizens, businesses should be able to file required reports without having to hire accountants and lawyers. Government employees should be able to do their work as easily, efficiently and effectively as their counterparts in the commercial world. An effective strategy will result in significant improvements in the government, including: Simplifying delivery of services to citizens;  
Eliminating layers of government management;

Making it possible for citizens, businesses, other levels of government and federal employees to easily find information and get services from the federal government;

Simplifying agencies' business processes and reducing costs through integrating and eliminating redundant systems;

Enabling achievement of the other elements of the President's management Agenda; and

Streamlining government operations to guarantee rapid response to citizen needs.

### 1.2 Business Case for E-Government

Electronic service delivery offers huge opportunities to improve public services for the benefit of citizens; more convenient, more joined-up, more responsive and more personalized. It is going to transform the way the public sector does business, in many cases replacing traditional channels for doing business with more efficient and effective electronic channels.

## 2. Benefits of E-Government

Less expensive – e-Government transactions eliminate the vast majority of brick and mortar and labor costs. E-Government transactions can be 65% less compared to OTC transactions. Using e-government leverages technology to reduce the cost of each transaction offered.

More convenient hours – e-Government transactions are available 24 hours a day, 7 days a week. This provides customers the flexibility to process transactions outside standard government office hours.

Reduced travel and waiting– Ubiquitous access is available from any home or off-site computer or from any phone. E-Government removes the travel time to a government office and eliminates the associated wait-time involved as well. An ancillary benefit is reduced wait-times for OTC transactions due to fewer customer visits.

Benefits all customers – e-Government benefits those that use the services and those that do not. As more and more transactions move from in-line to on-line, the customer that does not use e-Government is able to get better service while in a government office due to reduced wait time and ability of staff to focus on more complex transactions.

Reduction in bad check processing - Bad check processing time and expenses will decrease due to the fact that more customers will be utilizing credit cards to pay for their transactions.

Process improvement - e-Government often serves as a catalyst to perform business reengineering. Process improvement must continue when analyzing service for e-government.

## 2.1 Delivery of Services

Individuals/Citizens: Government-to-Citizens (G2C); Build easy to find, easy to use, one-stop points-of-service that make it easy for citizens to access high-quality government services.

Businesses: Government-to-Business (G2B); Reduce government's burden on businesses by eliminating redundant collection of data and better leveraging E-business technologies for communications.

Intergovernmental: Government-to-Government (G2G); Make it easier for states and localities to meet reporting requirements and participate as full partners with the government in citizen services, while enabling better performance measurement. Other levels of government program delivery because more accurate data is available in a timely fashion.

Intra-governmental: Internal Efficiency and Effectiveness; Make better use of modern technology to reduce costs and improve quality of federal government agency administration, by using industry best practices in areas such as supply-chain management; financial management and knowledge management. Agencies will be able to improve financial management and knowledge management. Agencies will be able to improve effectiveness and efficiency, eliminating delays in processing and improving employee satisfaction and retention.

## 3. What E-Government should be?

Easy to use, connecting people with governments according to their preferences and needs.

Available to everyone, at home, at work, in schools, in libraries and other convenient community locations.

Private and secure, with the appropriate standards for privacy, security, and authentication generating trust-required for e-government to grow and serve the public.

Innovative and results-oriented, emphasizing speeds and harnessing the latest advances in technology.

Collaborative, with solutions developed collectively and openly among public, private, nonprofit, and research partners, on the basis of their experience and expertise.

Cost-effective, through strategic investments that produce significant long-term efficiencies and savings.

Transformational, harnessing technology through personal and organizational leadership to change the way government works, rather than merely automate existing practices.

## 3.1 E-Government for the People

The big idea here is e-the-people. E-government links people not just to each other and the e-commerce marketplace, but also to the public marketplace of ideas, debate, priorities, initiatives, innovation, services, transactions, and results. It puts ownership of government truly in the hands of all citizens.

Imagine government truly of, and for the people, where individuals and organizations no longer wait in line between eight and five on weekdays only, but where they can be online at any time or place they wish. A place not only to get information but also to complete transactions with government, get services, talk with elected representatives-even to vote.

Imagine people in government who are excited about using the Internet to make a difference and produce results, answering questions instantly, using secure network that cross organizational boundaries to serve the public. Imagine people in business enjoying fast and easy interactions with government that produce results in the public interest.

Imagine people in all sectors-government, business, non-profits, and the research community working together to make this happen quickly, creatively, and cost effectively. This is e-government- our government of the future, not the government of the past. But don't stop there. E-government is not just about speed, efficiency, or accessing information online. It can also be tailed by individuals according to their preference and needs.

Imagine individual citizens creating customized, one-stop sites for themselves online, where they can choose to get information, conduct transactions, or communicate with their elected representatives. Imagine having your own self-designed, interactive site where you can directly conduct all your business with government whenever you wish. You can pay taxes, check your Social Security earnings, find out whether your building permit has been granted, renew your driver's license after your site has reminded you without being asked that it is coming due.

You can also participate in public hearings, create communities of interest with other online, monitor voting records, and express your views to your representatives. In short, you can choose how and when to connect with government, with the ability to choose appropriate levels of privacy and security.

#### **4. Conclusion**

The current pace of technological change means that there are few certainties about future service delivery. But we do know that government has the potential to offer truly citizen-focused services.

Citizens will choose when and where they interact with government. For many services, government will be open 24 hours a day, 7 days a week. Citizens will be able to interact with government from home, at work or on the move.

Services will be delivered through multiple channels. Traditional channels will compete with new electronic channels. As well as the public sector, the voluntary and private sector will offer new interfaces to government services. For example, you may pay tax through your electronic bank or renew your driver's license.

Government will be organized to deliver services that are customer focused. A government gateway will allow the aggregation of data across functions by users of that data in the private and voluntary sectors, and by new aggregators acting as wholesalers in government data and information. New citizen-facing government, voluntary and private sector intermediaries will compete to offer the best combinations of services.

# E-Government and Lessons from E-Commerce: A Preliminary Study

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## Abstract

As businesses become more involved and savvy with electronic commerce (e-commerce), electronic government (e-government) can learn many lessons from them. The tremendous growth in e-commerce will spur many governments to launch comparable e-government services. The recent passage of federal law in the US has institutionalized e-government. Thus, many government bodies will become greatly involved with the Internet and its associated technologies in providing an array of government services that were once confined to *brick and mortar* operations. However, in deciding which applications will be most effective in serving their constituents and given their limited resources, governments might learn from the practices of businesses. As in the case of business to business (B2B) e-commerce, the exchange of information within and between government agencies will comprise the bulk of interactions or transactions. The results of a preliminary e-commerce survey suggest several areas that may prove to be more effective for e-government Extranet and Intranet applications.

## 1. Introduction

The shift from goods to services has led to an information-based economy that has been fueled by rapid and continual advances in information technology (IT) [19]. Consequently, more organizations have become engaged in various forms of electronic commerce (e-commerce), and information has become their primary resource. As e-commerce expands at phenomenal rates in

the private sector, electronic government (e-government) is beginning to take a hold. Estimates placed business-to-business (B2B) e-commerce spending between \$92 and \$142 billion [1], [14], and business-to-customer (B2C) at \$33 billion in the US during 1999 [1]. By the year 2004, total e-commerce spending in the US is expected to exceed \$3.2 trillion [14]. Based on the projected general population estimates of the U.S. Census Bureau for 2002 and the estimated proportion of adult Internet users projected by Gartner [9], 45 percent, the current number of adult Internet users (in the US) is estimated at 93.2 million people. This represents approximately 42 percent of the global Internet users [8] and it is expected to double by 2005 [9]. In contrast, approximately 40 million people in the US sought information from government web sites in 1999. However, this was expected to increase to 68 million in 2001, a 70 percent jump in two years [21]. The vast difference in the number of users and the sheer volume of transactions as suggested by the value of electronic markets strongly suggest the existence of many untapped opportunities for e-government. However, capitalizing on these opportunities may pose major challenges for resource-constrained governments and their agencies.

Generally, e-government entails the delivery of government services and information via the Internet [6]. Its applications can be placed into four groups: government information to citizens, external interactions between government and citizens (i.e., submitting forms, registration and tax returns, voting, bidding on government contracts, etc.), internal interactions between government agencies and their employees (i.e., access personnel information, file forms, manage budget and

accounting functions, paychecks, etc.), and interaction between government agencies at the federal, state or local level to share information. Although many predict e-government will lead to a total government cost savings between 1 and 2.3 percent and a .2 to .4 percent increase in productivity [13], many challenges in determining where to begin lie ahead. Several development and implementation options can be pursued, but some applications may result in greater benefits than others. Given the private sector's experience and success with its development of e-commerce, government might closely examine what has been done to avoid costly mistakes and direct resources to those applications that will benefit both government and the public the most [4], [13]. Based on the responses of several organizations, Intranet applications on document management, the posting of electronic forms, education and training, and the broadcast of information prove to result in enhanced communication, increased efficiency and productivity, and improved decision making. Extranet portal applications provide one-stop e-government service that facilitates easy access to citizens and business.

The purpose of this paper is to identify some of the more successful applications in e-commerce and suggest their application to e-government. A preliminary survey was conducted with several private and public organizations to identify the categories in which Intranet and Extranet applications were developed and to gauge the perceived benefits that resulted from their applications. Experiences from a state-sponsored e-government implementation project will also be related and discussed.

## 2. Review

Although the convenience of e-government will quickly win the favor of most people, the real motivation may lie in legislative pressures to reduce the cost of government operations. For many state government agencies, budgetary constraints, a steadily increasing population, and freezes on government hires place added burdens on their ability to service the public. In essence, fewer resources are available to perform an increasing amount of work. A possible solution is e-government, adopting an IT-based business model to electronically managing their charges. Rather than gathering information or transacting business at a physical location or over the phone, people will be able to conduct these tasks online over the Internet with 24x7 (i.e., 24 hours, 7 days a week) accessibility from nearly anywhere in the world. In many cases, successful e-government applications have increased efficiency and resulted in reductions to the cost of processing a transaction [5], [7], [17].

E-government's growth in popularity can be attributed to many factors. Heeks [12] identifies three of them: an unsustainable level of public expenditure that has not produced efficient government services, a resurgence of neo-liberal thinking emphasizing the efficiency of market competition and the need make government more business like, and the rapid

development of IT and the increasing awareness of its value. Government wastes, project delays and cost overruns, mismanagement of resources, and inadequate organizational and management skills have motivated lawmakers to seek nontraditional solutions, such as electronic services (e-services) and e-government. As in the case of the private sector, current e-government initiatives focus on four relationships [3]: government to citizens (G2C), government to government (G2G), government to employees (G2E), and government to business (G2B). Although 34 percent of the initiatives concern providing G2C services, 63 percent involves G2G (20 percent), G2E (23 percent) and G2B (20 percent) e-government applications. This suggests that a majority of e-government will be developed for the Intra- and Extranet.

The long-term push toward an information economy has also fueled the demand for e-services over the Internet [19]. In the private sector, e-services focus on understanding the customers' needs, and responding with goods and services often tailored specifically toward meeting those needs. Many businesses have begun investing in customer relationship management (CRM) systems to manage their interactions with their customers through dialogs [18] and build loyalty [15]. In pursuing such ambitious endeavors, businesses have shifted their focus from being production-centric to service-centric [19]. In a similar move, e-services bring government services to citizens through e-government, but with the benefits people enjoy from e-commerce [2]. Asfaw et al. [2] cite three important e-government issues European nations face: citizens should benefit from e-government as they do from e-commerce, government agencies should benefit from the efficiencies reflected in lower Internet transactions costs, and e-government should be capable of providing a competitive advantage in attracting businesses to the government's jurisdiction by streamlining processes (i.e., securing licenses and permits, submitting tax and employee periodic reports, etc.). The applicability of these issues is ubiquitous and can be extended to all implementations of e-government. Thus, the objectives of e-government can parallel those of e-commerce, but from a different perspective.

Throughout the US, e-government has been gaining momentum. Recent developments in the U.S. Congress reflect greater interests in establishing an e-government stronghold. The E-Government Act of 2001 calls for creating a federal office for the country's chief information technology officer (CIO). Along with the functions of promoting e-government, the CIO would provide leadership and oversee the Internet access of government services and information, the implementation of government-wide information policies, and other functions prescribed by the Paperwork Reduction Act [21]. If enacted, the E-government Act will institutionalize e-government, and provide it with the necessary legislation to ensure its expansion.

Currently, the U.S. Patent and Trademark Office (USPTO) embraces e-government through its electronic trademark filing system that allows customers to interact

with the agency through the Internet [7]. The system also allows USPTO attorneys to conduct patent and trademark searches online and publish its gazette on the Internet. E-government has helped USPTO improve the quality of their interactions with customers, increase worker productivity, and retain highly trained examiners. By 2003, the office expects to handle 80 percent of its applications (for patents and trademarks) and communications electronically.

Another federal agency, the Department of Housing and Urban Development (HUD), has called on e-government to help improve its regulatory management requirements with owners and managers of government assisted housing [5]. HUD has divided its system to fit the needs of critical five areas: active partners performance system, mortgage delinquency and default monitoring, financial assessment subsystem, tenant assessment subsystem, and resident service and satisfaction survey. The system meets the three strategic objectives set by HUD: to reduce paperwork for HUD's partners and clients, to provide greater accessibility for clients to interact with HUD, and to improve HUD's affordable homes program's integrity. Overall, the system has improved HUD's operations and allowed it to keep participating owners and managers (of government assisted housing) abreast of federal and state regulatory requirements. Although limited in their scope when compared to the e-commerce applications in the private sector, the USPTO and HUD systems serve as a prelude to what can be achieved with e-government. To become fully e-government, organizational changes will have to be implemented to transition government agencies to information-centric business models that will allow them to take advantage and reap the benefits of e-government.

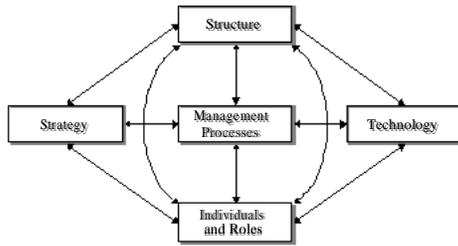
Many state governments have approached e-government through portals to promote e-services, integration and information sharing among agencies. Portals act as gateways that allow Internet users (i.e., constituents, government personnel) to access an array of government services and resources through a single web site in a similar manner to *one stop shopping*. In several cases, they will contain links to various agency web sites. For users, portals reduce their search costs as they provide a single point of contact for online government services [10]. Government agencies benefit from portals in many ways, such as to provide package services in a similar manner to those offered by businesses, reduce the service-processing costs, and improve government accessibility. Some of the recent developments (with portal web sites) include:

- MyGov in California allows people to personalized their e-government services (similar to MyYahoo) by selecting those most relevant to their needs;
- An ambitious e-government project in Hawaii will allow tax payers to file their income tax returns online. Not only will the system improve the tax agency's services to tax payers and its internal efficiency, but it may also increase tax revenues by increasing the accuracy

of the returns, reducing the time for the state to act upon delinquent tax returns, and decreasing the time to collect taxes owed to the state. The state anticipates similar processing cost savings on a single tax return to those reaped in the state of Texas where the cost dropped from \$1.66 to 33 cents [16];

- MyCalifornia extends several services to California citizens, including automobile registration, tax forms and refund status, fishing and hunting permits, hazardous waste disposal instructions, and state contracting information [17];
- NC@YourServices in North Carolina features e-procurement, online government purchasing, and involved the collaboration of many state and local agencies [17];
- PowerPort of Pennsylvania provides simplified online access to wide variety of government services, such as information and forms for business interested in locating to Pennsylvania, filing income tax returns, a calendar of state-wide events, the governor's press releases and more [17].

In spite of these instances of success, e-government still faces many challenges and management issues. As in the case of commercial enterprises entering e-commerce, government agencies will be confronted with organizational issues, especially those involved with the radical change from one business paradigm to another. Paradigms embodied in traditional (*bricks and mortar*) business models drastically differ from those in e-commerce business models. Whereas traditional business models concentrate on the physical acquisition of resources and placement of products and services, IT-enabled e-commerce business models focus on information (and its ensuing knowledge) as the organization's primary resource. Hence, the paradigm shift dictates that organizations engage in e-commerce develop their solutions through information leveraging, rather than methods, such as physical optimization models. The transition to e-government will hold the same challenges to government agencies, moving from solving problems with physical solutions to electronically leveraging information both within the agency and between it and its partners (i.e., other agencies). Led by changes to the agency's strategy and its adoption of Internet-enabled IT, changes to the organization structure, management processes, and the roles and individuals will be required to functionally realign them. The MIT90 framework [20] illustrates the interrelationships of these five components (Figure 1). Essentially, changes to any of the components will result in compensatory changes in the others.



**Figure 1. MIT90 framework**

Increasing interests in e-commerce and recent endorsements of the concept have raised the demand for e-government and ensured its future. Many of the current e-government applications, though, focus on supplying government information to citizens, and supporting external interactions between government and citizens (G2C). Little progress appears to have been made in developing applications for internal interactions between government agencies and their employees (G2E), and those between government agencies (G2G). Yet, in e-commerce, the greatest benefits (and profits) arise from B2B interactions and transactions. Most e-commerce activities appear concentrated on B2B with B2B spending anywhere between three to four times greater than that of B2C. Businesses that benefit the most from e-commerce tend to be organizationally e-commerce designed, particularly capable of leveraging information, distributing information both within itself and between partners in vertical and/or horizontal integration alliances. For e-government to achieve the same levels of success as e-commerce, perhaps governments should examine the factors contributing to its (e-commerce's) success and adopt (or adapt) them.

### 3. Lessons from an e-Commerce Survey

A preliminary e-commerce survey was conducted to determine the types of Intra- and Extranet applications that were most frequently pursued and the perceived results of their e-commerce applications. Fifty private companies and government agencies in California that were engaged in developing successful e-commerce applications were contacted. Of the 50 sent, 32 usable surveys (i. e., 23 from the private sector, 9 from government) were received for a return rate of 64 percent. The high return may be attributed to advance planning; organizations were contacted in advanced and agreed to participate in the survey. Because all organizations were well-established and experienced in developing e-commerce applications, their responses can be considered an accurate reflection of all organizations in the state.

Among the several items in the instrument, two groups focused on Intra- and Extranet applications. Intranet applications reside on an internal server, and are distributed through a network behind the organization's firewall and launched through a user's web-browser. Thus, they are private and can be accessed only from within the organization. Participants were asked of which

Intranet nine applications that were listed had their organizations implemented. The results appear in Table 1. The top four applications were document management (78.1 percent), post electronic forms (71.9 percent), education and training (71.9 percent), and broadcast information (65.6 percent). Based on these results, organizations are more inclined to develop informational Intranet applications.

Intranet Applications	Number Implemented (Percent)
Document management	25 (78.1)
Post electronic forms	23 (71.9)
Education and training	23 (71.9)
Broadcast information	21 (65.6)
Project management	19 (59.4)
Team collaboration	18 (56.3)
Software distribution	17 (53.1)
Inbound logistics	5 (15.6)
Other	2 (6.3)

**Table 1. Intranet applications**

The perceptions of Intranet benefits were measured on a seven-point Likert-type scale (1 = not benefited, 7 = greatly benefited). Table 2 shows the means and medians of the five items. The survey responses indicate that greatest perceived gains from Intranet applications are from enhanced communication (6.2), increased efficiency (5.6), increased productivity (5.5), and better decision making (5.3). Respondents benefited to a lesser extent from reduced cost (4.9). These perceptions suggest that most organizations develop Intranet applications to enhance and improve their distribution of information.

Perceived Intranet Benefits	Mean/Median (1 = not benefited, 7 = greatly benefited)
Enhanced communication	6.2/6
Increased efficiency	5.6/6
Increased productivity	5.5/6
Better decision making	5.3/5
Reduced costs	4.9/5

**Table 2. Perceived Intranet benefits**

Extranet applications tend to be directed toward supporting the interactions between organizations, often those engaged in partnerships or alliances. Characteristically, Extranets connect their individual Intranets together, therefore they are private. As in the case of Intranet applications, participants were asked to indicate which of the listed 12 Extranet applications their organizations had implemented. Table 3 displays the results. The results suggest that Extranet applications tend to involve interactive support and provide information. Customer service and support (65.5 percent), post electronic forms (46.9 percent), marketing and

advertising (46.9 percent) and products/services catalog information (43.8 percent) applications were more frequently implemented.

Extranet Applications	Number Implemented (percent)
Customer service and support	21 (65.6)
Post electronic forms	15 (46.9)
Marketing and advertising	15 (46.9)
Products/service catalog information	14 (43.8)
Electronic data interchange (EDI)	12 (37.5)
Collaboration between business partners	12 (37.5)
Portal	11 (34.4)
Sales	11 (34.4)
Publish information among business partners	10 (31.3)
Production and inventory control between business partners	9 (28.1)
Electronic funds transfer (EFT)	7 (21.9)

**Table 3. Extranet applications**

Participants were also asked to indicate the perceived benefits they received from Extranet applications. Table 4 summarizes the responses to the 11 items. Enhanced communication (6.2), increased productivity (5.5) and greater efficiency (5.5) ranked among the five highest perceived benefits as they did among those for Intranet benefits. Improved customer satisfaction (5.6) and better coordination between business partners (5.3) also appear among the top five.

Perceived Extranet Benefits	Mean/Median (1 = not benefited, 7 = greatly benefited)
Enhanced communication	6.2/6
Improved customer satisfaction	5.6/6
Increased productivity	5.5/6
Greater efficiency	5.5/6
Better coordination between business partners	5.3/6
Reduced costs	4.9/5
Increased profitability	4.8/5
Competitive advantage	4.8/4
Improved inventory control	4.8/4
Reduced production time	4.5/4
Increased sales and market share	4.4/5

**Table 4. Perceived Extranet benefits**

The responses from participants of the survey suggest general trends toward developing applications

that will result with the greatest acceptance, benefit and support of the organization's strategy. The perceived benefits can be translated to application objectives. Thus, both provide an insight to what governments should focus on with e-government.

#### 4. Discussion

While businesses have learned to use Intra- and Extranet applications to gain competitive advantages and efficiencies, interests in the public sector have been slow to develop. However, recent developments suggest that government has begun to take notice of their benefits. Traditionally, governments at all levels face constraints imposed by their bureaucratic structure and legislative rules. In contrast to businesses, governments are less motivated by the economic gains in adopting new technologies. Yet, in recent years increasing public pressures have led to the expansion of e-government. Most of the efforts to deploy e-government applications have primarily targeted supporting administrative tasks and automating governing functions. Given the vastness of e-commerce, e-government has many opportunities to explore and lessons to be learned.

Few differences separate government and private sector Intranet applications. As in the case of most businesses, government agencies can use the Intranet as a tool and arena for document management, posting electronic forms, training and broadcasting information. The nature of government often places burdensome demands on the physical movement of paper documents. Even simple, routine administrative tasks require enormous loads of paper work. Many government agencies have found that the Intranet provides an inexpensive, secure and convenient means for disseminating information. Using the Intranet for document management facilitates communications between employees, and in return, lends speed to complex decision making process. The paper-less flow of documents and information also results in enhanced efficiency and productivity as information is exchanged immediately.

Global businesses have relied upon the Intranet as an important communication link between geographically distributed sites. The same can be applied to e-government to link and bridge an agency's geographically disbursed districts. For example, the State of Hawaii relies upon its Intranet to distribute documents among its four districts, each of which is composed of one or more islands separated by miles of open seas. Before the implementation of their Intranet, hard copy documents were mailed among the districts. Physical delivery naturally means slower responses and longer waits than e-mail, Intranet-site access or document distribution over a Local Area Network (LAN). The Hawaii Department of Taxation takes advantage of Intranet technologies and now posts its tax codes and tax law changes through the Intranet. As a result, every tax clerk has immediate and complete access to them. Consequently, the easy access and convenience greatly bolsters their customer service and significantly improves

their responses, both in time and quality, to customer inquiries. The state also uses its Intranet to log production system incidents and reports. The department's system administrator and operators can now monitor the system from anywhere and at anytime through their Intranet website. These successful e-government applications reflect what many global companies, such as Intel, Hewlett-Packard and others, have learned in the past, and have helped e-government enhance communication within an agency, and improve efficiency and productivity through time savings.

A few of survey respondents noted that their organization's Intranet was often used for software distribution. Many organizations have found that sending a technician to upgrade a user's computer can be very expensive in terms of both the technician's time and employee downtime (i.e., productivity while the computer is down). A solution commonly used to overcome this problem in the private sector involves an Intranet approach. Intranet users can download software and software patches at anytime with no or very little assistance from the technical support staff. This helps reduce downtime since the upgrades can be implemented as soon after they are available (versus waiting for someone to install them). Many government agencies are also beginning to use the Intranet to inform the computer help desk staff of software problems and track the help ticket status, another common practice in the private sector. With a simple Intranet help desk application, users can log onto the Intranet site and write a help ticket; help desk staff will then be assigned to fix the problem and clear the ticket. The system maintains the history and the status of the help ticket. Thus, the ticket can be tracked and retrieved anytime. The Secretary of State's Office in California uses an expert system to determine the severity of the user's problem. Those problems that cannot be easily identified by the expert system are forwarded to technical experts. Otherwise, they are handled in a routine manner.

As with the Intranet, Extranet applications reap many benefits, such as enhanced communication through the collaboration and coordination between government agencies, greater efficiencies and productivity, and improved customer satisfaction. With e-government, the Extranet can serve to link government agencies at the local, state and federal levels. In the US, a viable business model using the Extranet has been proposed to enable a system for child support welfare monitoring. Under the current system, government agencies spend an enormous amount of taxpayer-resources to track noncompliant parents (i.e., parents who do not comply with court orders that require them to make child support payments) and provide welfare benefits. Benefits may be paid to the recipient through different agencies and funding sources, and their efforts may overlap or lead to inconsistent classifications. Problems in linking child support agencies at different levels are often blamed on the agencies use of different systems, and varied computer resources and expertise. If their Intranet applications can be designed to interface with each other

in their Extranet (as in the case of B2B partners), not only will child support agencies be able to coordinate and collaborate with one another in real time and anytime, and become more efficient, but their communication and productivity would be enhanced through the exchange (transfer) of information. In the end, the recipient would receive improved services.

Although businesses possess greater experiences with their e-commerce, differences between the (organizational) missions of business and government dictate differences in their delivery of services. In contrast to businesses, which deploy portal applications mainly within the organization boundary, e-government has seen a trend toward using portals to collaborate and coordinate among different government agencies and bundle government services together that are offered to citizens. Portals are single-point Web browser interfaces used to promote the gathering, sharing, and dissemination of information as well as the provision of services to communities of Interest [11]. Businesses tend to use portals to handle structured and/or unstructured data for business intelligence, knowledge management, training, and etc. With e-government, portals allow various government agencies share information to improve the efficiency of citizen searches for and access to services.

Successful implementations lead to a serious and positive impact on the company's bottom line. Companies can find off-the-shelf products from Brio Technology, Business Objects, DataChannel, IBM, Informix, Microsoft, Oracle and Sybase that can handle these tasks. Large consumer portals, such as Yahoo, also offer lessons and models for e-government projects to follow. Thus, businesses play an important role in the portal applications used in the public sector. In recent years, governments have been learning from businesses in the area of design and rollout of internal corporate portals for knowledge assimilation and distribution. Yet, interestingly, most government portal sites are designed and maintained by private companies, and lease by government agencies.

With more government agencies using portals as the gateway for government services, a trend has been seen to design the portal website around the life event of citizens. For example, MyGov in California can be customized by a citizen (user) to include major state government services such as birth certificate, driver license renewal, car registration, state tax returns, and etc. The advantage of this model is that it promises *one stop shopping* for government services.

Many lessons from businesses' use of their Intranets and Extranets can be learned to direct e-government toward developing more effective network applications. However, they (Intra- and Extranets) by themselves cannot revolutionize government, and planners should remember that technology may provide only partial solutions. First, the Internet technology should not just be used to refurbish government with cutting-edge technologies, but should be exploited to the full-length in automating administrative tasks and government services. Secondly, the e-government services should not stop at

just digitizing the existing work processes, but should be the redesign and re-engineering of work processes and government functions. Lastly, e-government initiatives should be proactive, strategic moves but not reactive, tactical decisions.

## 5. Summary and Conclusion

A few general conclusions can be reached from the lessons reflected in the survey results. Businesses' experience with development of e-commerce applications provides governments with a wealth of knowledge that can be used to avoid making the costly mistakes and better direct their limited resources to those applications that will be most effective. E-government as well as e-commerce will continue to grow because it offers real benefits. Intranet and Extranet applications will comprise the bulk of resources, yet they may yield insurmountable benefits. The lessons that surfaced from a preliminary e-commerce survey suggest that e-government Intranet should concentrate on document management, the posting of electronic forms, education and training, and the broadcast of information. The benefits that were reported include enhanced communication, increased efficiency and productivity, and improved decision making. For Extranet applications, most respondents indicated their organizations focused on customer service and support, electronic forms posting, marketing and advertising, and products/service catalog information. To a lesser degree, though, collaboration between business partners and portal were ranked in the middle. In contrast to Intranet responses, enhanced communication, improved customer satisfaction, increased productivity, greater efficiency, and better coordination between business partners were cited most frequently as Extranet benefits. The differences between business and government objectives may account for the difference in their actually applications.

## References

- [1] Ah-Wong, J., Gandhi, P., Patel, H., and Shah, U. (2001). E-commerce progress: Enablers, inhibitors and the short-term future. *European Business Journal*, 13, 98-107.
- [2] Askaw, T., Karun anayake, K., Mehta, M, and Parnaik, A. (2001). E-commerce progress: International comparisons. *European Business Journal*, 13, 90-97.
- [3] Balutis, A. (2001). E-government 2001, part I: Understanding the challenge and evolving strategies. *Public Manager*, 30:1, 33-37.
- [4] Balutis, A. (2001). E-government 2001, part II: Evolving strategies for action. *Public Manager*, 30:2, 41-45.
- [5] Bell, J., and Livanec, M. (2002). HUD embraces technology, *Journal of Property Management*, 67:2, 32-36.
- [6] Biancucci, R.J., Goode, L.J, Hunter, P.A., and Owings, K. (2001). 2001 CFO survey--preview: Electronic government. *The Journal of Government Financial Management*, 30, 36-38.
- [7] Chasser, A. (2002). The business of e-government. *Managing Intellectual Property*, Feb., 52.
- [8] The Futurist (2001). *Outlook 2002*. 35:6, O1-9.
- [9] Gartner, Inc. (2002). Gartner predicts 2002: Top 10 predictions. [www4.gartner.com/DisplayDocument?doc\\_cd=103726](http://www4.gartner.com/DisplayDocument?doc_cd=103726).
- [10] Grant, J.P., and Grant, D.B. (2001). Web portals and their role in e-government. In 2001 Proceedings of the Americas Conference on Information Systems.
- [11] Gronlund, A. (2002). *Electronic Government: Design, Applications & Management*. Hershey, PA: Idea Group Publishing.
- [12] Heeks, R. (2000). *Reinventing government in the information age*. London: Routledge Press.
- [13] Hyde, A.C. (2001). Management fad of the year 2000: "E-gov". *Public Manager*, 30:1, 29-32.
- [14] Kelly, S (2000). An e-commerce explosion. *Communications News*, 37:9, 8.
- [15] Kohli, R., Piontek, F., Ellington, T., VanOsdol, T., Shepard, M., and Brazel, G. (2001). Managing customer relationships through e-business decision support applications: a case of hospital-physician collaboration. *Decision Support Systems*, 32, 171-187.
- [16] Newcombe, T. (1998). "You've got a refund." Tax agencies take to the Internet. [egov.govtech.net/reports/pastreports/dec98/refund/refund.p.html](http://egov.govtech.net/reports/pastreports/dec98/refund/refund.p.html).
- [17] Noack D. (2002). Government web sites: A status report. *Link-up*, 19:3, 2, 23.
- [18] Peppers, D., Rogers, M., and Dorf, R. (1999). *The one-to-one fieldbook*. New York, NY: Currency and Doubleday.
- [19] Rust, R. (2001). The rise of e-service. *Journal of Service Research*, 4, 283.
- [20] Scott Morton, M. (1995). *The corporations of the 1990s*. New York, NY: Oxford University Press.
- [21] Tilman, B. (2002). E-government bill waits in the wings. *Information Management Journal*, 36:3, 10-14.

# Taxation of Electronic Commerce

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## Abstract

No other innovation, or way of doing business, has revolutionized the international economy faster than the Internet. It took generations for the Industrial Revolution to play out around the world while the Internet Revolution has unfolded in less than a decade. The speed of this change has been astounding. In the Industrial Age, as change took place, governments were able to react accordingly. In the Internet Age, today's innovation is tomorrow's standard. Government are finding that they must act on Internet time, which is a daunting challenge.

This paper examines the current state of affairs with regards to the taxation of Internet commerce. It analysis the historical perspective of the United States of America, the OECD, the WTO, and the European Union; and attempts to answer the question "What happens next?" Is there an opportunity here for developing countries to increase their tax base?

## 1. Introduction

The biggest standards battle in the history of the digital revolution has again heated up and the fight is about taxes – taxes on e-commerce. The unprecedented growth in the Internet during the "internet bubble economy" highlighted the glaring problems with current taxation laws that address the remote purchases of goods and services. While these problems and concerns may have been sidelined during the past couple of years with the "busting of the internet bubble", the worsening of the worldwide economic slowdown and the surfacing of the global war on terror; they have not been adequately addressed.

And, Internet commerce is not dead. Recent statistics released from the US Census Bureau of the Department of Commerce (20) shows that Internet commerce has risen during the last quarter of 2001 and the first quarter of 2002 in comparison to the last quarter of 2000 and the first quarter of 2001. There estimate of U.S. retail e-commerce sales for the first quarter of 2002, not adjusted for seasonal, holiday, and trading-day differences, was \$9.849 billion, an increase of 19.3% from the first quarter of 2001 Fig.1

Total retail sales for the first quarter of 2002 were estimated at \$743.8 billion, and increase of only 2.7% from the same period a year ago. E-commerce sales in the first quarter of 2002 accounted for 1.3 % of the total sales while in the first quarter of 2001 e-commerce sales were 1.1% percent of total sales.

The United Kingdom statistics also show a startling increase in e-commerce sales (3). The Interactive Media

(2) Retail Group (an industry body for global retailing) is now collecting hard date on online sales to UK consumers. Their IMRG Index provides robust evidence that the UK e-retail market is significantly larger and growing faster than previously estimated. The Index rose to 262 in April 2001, up from 100 in April 2000 – giving an estimate of e-commerce retail sales for the month of April 2001 of 210 million pounds sterling (16).

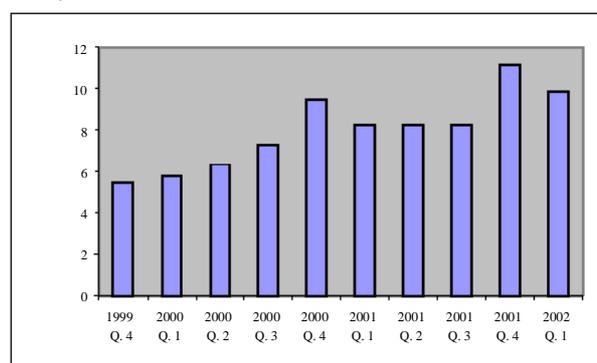


Figure 1: U.S. e-commerce retail sales

This increase of 162% in e-commerce retail sales compares with only a 5.9% increase in general retail sales. Figures from the Index similarly show an increase of 10.4% in March, 2002 compared with February, 2002 and the organization estimates that e-retail will continue to grow ten-times faster than mainstream retail, with no indication that any sector is beginning to plateau.

In a press release dated June 2002 (13), they stated "Half a billion people are online at home worldwide and a third of them shop online." They continued, "Europe now has more internet users than the US. The UK is responsible for a third of all e-retail sales in Europe, with online sales worth an estimated £507 million in May (2002) alone. Internet sales continue to surge, against the general retail trend, but while these direct sales are the most concrete manifestation of e-retail, and may reach 15% of all retail within a few years, they are only one element in the e-commerce equation."

They also highlighted that "throughout the first half of 2002 a steady stream of positive reports have been issued by e-retailers, whose ventures are showing profits - many for the first time - and experiencing rapid growth in sales. The UK e-retail market is currently growing at over 90% year-on-year, and is expected to be worth £7 billion this year (2002), representing almost 4% of the total retail market by the end of the year".

IDC Research confirms these figures (11). As the world's leading provider of technology intelligence, industry analysis, market data, and strategic and tactical

guidance to builders, providers, and users of information technology; their recent research suggests that more than 600 million people worldwide will have access to the Internet - spending more than \$1 trillion online. While the United States now accounts for 40 percent of the money spent online, they suggest that as residents of Asia and Western Europe increase their spending, The U.S. should only account for 38 percent by 2006. In some Asian nations, governments are lobbying to bring more citizens online, thus contributing to rapid Internet penetration in those markets. In Western Europe, e-commerce is expected to rise 68 percent this year as the adoption of the Euro brings better competition, price transparency, and improved deals for online buyers.

Accordingly, governments at all levels and all types of retailers are now addressing the best way to deal with legislative shortcomings surrounding the taxation of e-commerce; with local government groups pushing for tax assessment based on where the purchaser lives rather than the seller's location, and businesses lobbying for a neutral, fair and equitable, easily administered system. The EU recently acted unilaterally with their Electronic Commerce Directive.

## 2. The Problem

It is unquestionable that developments in e-commerce and new business models have allowed all kinds of businesses to change their trading practices in ways that were unimaginable when tax rules were developed for traditional business models. The emergence of the commercial Internet has opened new routes for the exchange of goods and services. Almost any goods that can be digitized can be bought, sold and distributed quickly and inexpensively through the Internet to consumers worldwide. Substantial questions remain, however, about how electronic commerce will be treated by the various laws of taxation.

Electronic commerce raises domestic and international tax issues. Specifically:

1. There are unique problems in tax administration posed by electronic commerce.
2. There are sales and use tax issues, such as nexus and the non-uniform (and sometimes inconsistent) manner in which tax laws treat electronic commerce-related activities.
3. There are international taxation issues arising under domestic taxation laws and foreign value added tax systems (with this changing business climate, tax authorities the world over have been particularly concerned that private customers would buy digital products and services from non domestic suppliers because no sales tax was due on these products).

Most nations have in place a system of tax laws and regulations which govern the tax treatment of goods and services crossing their borders and assert taxing jurisdiction on the basis of the "source" of income and the residence of the entity earning the income. For example, determining the source of income is important both to businesses in the United States and to foreign entities

doing business in the United States. Under the Internal Revenue Code (I.R.C.) (21), United States citizens and residents ordinarily are fully taxable in the United States on income which is derived from sources outside the United States, subject to certain exemptions and limitations. A corporation created or organized in the United States also is taxable on its worldwide income. Foreign entities, however, are generally only taxed in the United States on income generated from sources within the United States. For example, nonresident aliens in the United States and certain foreign corporations in the United States are taxed on income which is "effectively connected" to the conduct of a trade or business within the United States.

Taxation of international commerce also depends on the provisions of various international bilateral tax treaties. Among the most important concepts in these treaties is that of "permanent establishment," which is essentially a fixed place of business through which the business of an enterprise is wholly or partly carried on. To prevent double taxation of international activity, countries generally tend to restrict their taxation of business profits to those profits that are attributable to a permanent establishment in their jurisdiction.

The Internet raises difficult unresolved questions about how to determine whether an entity engaged in electronic commerce is engaged in a trade or business in a particular country or has a permanent establishment in that country for tax purposes. Parties engaged in electronic commerce, for example, may not have, or need, a physical place of business in a country in order to conduct extensive business online in that country. Thus, it is not always clear whether they have a permanent establishment which would give rise to any tax obligation. It is unlikely, however, that foreign electronic vendors who merely solicit orders within a country and then ship tangible goods into that country based on those orders will be considered as engaging in a trade or business in that country.

### 2.1 Where's the Nexus?

The power of a state to impose income taxes or sales or use taxes, or an obligation to collect taxes, depends on whether a "nexus" exists which would support a state's taxing jurisdiction. "Nexus" essentially means a "contact or link" – a contact or link which forms the legal basis for the imposition of taxes. Only those parties having sufficient contacts or links with a state are subject to taxes by that state - some minimum connection or link between the taxing state and the person, property, or transaction it seeks to tax. Where is the "nexus" in electronic commerce: is it between the seller and his home state, the seller and the state of the customer, the customer and the state of the seller, the customer and his/her state of residence, the internet service provider and their resident state, the internet service provider and the home state of the customer, or the internet service provider and the state of the seller? These questions still have to be answered.

In addition, if nexus exists for online transactions, the question of what, actually, is subject to sales and/or use tax remains. In general, this depends on how the transaction in question is classified under sales and use tax laws. Normally, governments distinguish between transactions in tangible personal property, services and intangibles and take a variety of approaches to classifying electronic activities under sales and use tax statutes, with little uniformity or guidance in their application. Sales and use taxes are normally imposed on retail sales of tangible personal property unless the law provides for a specific exemption or exclusion. "Tangible personal property" typically includes material goods that may be perceived by the senses. Services are not generally covered by sales and use tax unless the law specifically enumerates the services as taxed. Although services are less extensively taxed than tangible goods, over the years there has been a gradual broadening of the tax base for services. Intangibles, such as transfers of stocks and bonds or intellectual property rights, generally are not subject to sales tax. Sales and use taxation of intangible intellectual property rights has been an important issue in taxation and, given the important role that licensing plays in electronic commerce, promises to continue to be important in the future.

Taxation in connection with electronic commerce must also take into account the unique features of the Internet and other electronic networks. Most tax laws and regulations were established before the rise of electronic commerce, and are rooted in concepts of physical location or presence. Determining the identities of the parties who participate in a transaction, where a transaction is "sited," and identifying key "taxing points," for instance, are often important to the administration of taxes. These concepts, however, may be difficult to analogize to transactions occurring in cyberspace.

## 2.2 The Problem of Lost Revenue!

Not requiring internet-based merchants to collect sales and use taxes, places them at a significant advantage over traditional retailers. This inequity could have a profound negative impact on not only retailers but local communities because it risks governments' ability to collect the revenue needed for education, police, and other essential services, and could lead to increases in property or income taxes. In the United States nearly 40 percent of all state revenues come from the sales tax; it is the single most critical source of funding for public education. There is serious concern in the United States that unless the Congress moves to restore a level playing field by taxing internet commerce, current industry and academic studies project American States will lose between \$10-20 billion in sales tax revenues by 2003, \$45.2 in 2006 and as much as \$54.8 billion by 2011 – Figure 2 (5).

Given the above, it obvious why a central theme in the debate over the tax treatment of internet commerce centers around the extent to which the inability to tax them has eroded government sales tax collections.

Revenue losses from e-commerce generally arise because e-commerce enables a significant increase in remote sales, thereby causing a shift from collecting sales taxes at the point of sale to collecting use taxes for goods used, consumed, or stored in a jurisdiction. The resulting revenue losses are generally the result of tax evasion, not tax avoidance, since the use tax is due even if the sales tax cannot be collected.

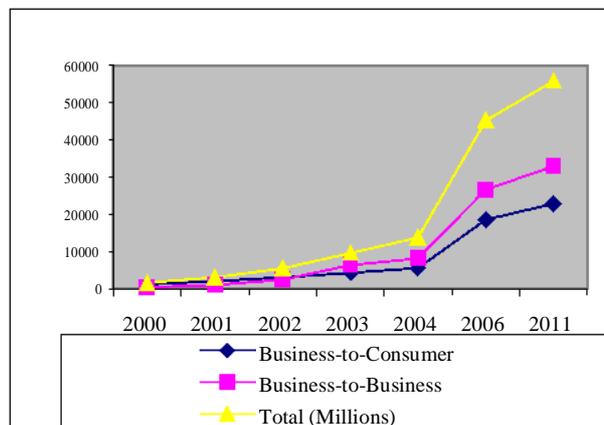


Figure 2: U.S. sales tax losses on electronic commerce

## 3. Are We Close to a Solution?

### 3.1 The Clinton Proposal:

In July 1997, the US discussion on e-commerce taxation was formalized in the Clinton Administration report entitled "A Framework for Global Electronic Commerce"(6). It articulated the United States government's view that governments should adopt a "non-regulatory, market-oriented approach to policy development around electronic commerce". The paper set forth five principles for facilitating the growth of commerce on the Internet:

1. The private sector should lead.
2. Governments should avoid undue restrictions on electronic commerce.
3. Where governmental involvement is needed, its aim should be to support and enforce a predictable, minimalist, consistent and simple legal environment for commerce.
4. Governments should recognize the unique qualities of the Internet,
5. And, electronic commerce over the Internet should be facilitated on an International basis.

It expressed the government's view that the Internet should be a tariff-free environment, and committed that the United States would advocate The World Trade Organization and other international groups to declare the Internet to be tariff-free "whenever it is used to deliver products or services". The Paper also stressed the US governments position that no new taxes should be imposed on electronic commerce and that taxation of such commerce should be consistent with established principles of international taxation. Further stating that

taxation of Internet sales should neither distort nor hinder commerce, be simple and transparent, and be able to accommodate tax systems used by the United States and its international trading partners.

### 3.2 The Internet Tax Freedom Act of 1998:

The Clinton Proposal was followed by the Internet Tax Freedom Act of 1998 (14). Concerned with the negative effect of taxation by local governments on the growth in online sales; the US Congress, with Clinton Administration backing and the support of John McCain in the Senate, attempted (with minor exceptions) to make the Internet a tax free zone. This legislation established a three-year moratorium on the state and local taxation of Internet access and "multiple or discriminatory taxes on electronic commerce". The Act's major e-commerce provisions included:

- A ban until October 1, 2001, on any new taxes on Internet commerce or access charges.
- Grand-fathering of existing taxes.
- And, the creation of an Advisory Commission on Electronic Commerce (ACEC), which found in their Report to Congress "governments should keep the tax and administrative burden on consumers and businesses as low as possible", and outlined "It should not be presumed that the collection of sales and use taxes on internet transactions is an inevitability" (1).

The ITFA's statutory language suggested several specific topics for the Commission to study, including an examination of:

- The collection and administration of consumption taxes on electronic commerce in other countries and the United States, and the impact of such collection on the global economy, including an examination of the relationship between the collection and administration of such taxes when the transaction uses the Internet and when it does not.
- The impact of the Internet and Internet access on the revenue base for telecommunications excise taxes.
- Model state legislation that would provide uniform definitions of transactions subject to or exempt from sales and use taxes and would ensure that Internet access, online services, and transactions using the Internet, Internet access or online service would be treated in a tax and technology neutral manner relative to other forms of remote sales.
- The effects of taxation, including the absence of taxation, on all interstate sales transactions, on retail businesses and on state and local governments to collect sales and use taxes owed on interstate purchases from out-of-state sellers.

A proposal submitted to The Commission by state and local governments (8), sought a uniform sales tax regime that would have applied to e-commerce and other remote-sales transactions where the seller does not have a presence "or nexus" in the state where the buyer is – although not uniformly applied, the US Supreme Court has upheld the "nexus" test.

This moratorium on (amongst other things) new, multiple and discriminatory taxes on internet commerce expired October 21, 2001 at midnight after the U.S. Senate successfully rejected an effort to take up legislation passed by the House to extend the ban for two years.

### 3.3 The US Streamlined Sales Tax Project:

The U.S. Streamlined Sales Tax Project began in early 2000 as an initiative by state governments (via the Committee on State Taxation – COST (7)), with input from local governments and the private sector, to simplify and modernize sales and use tax administration for all types of commerce.

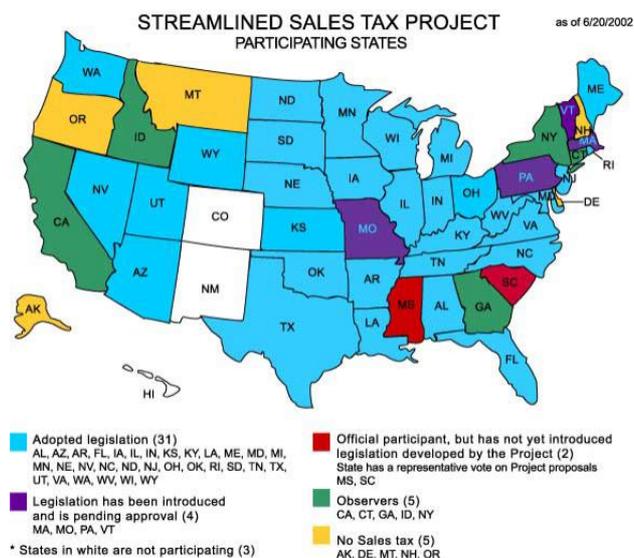


Figure 3: Streamlines sales tax project – participating states

This simplified system was to incorporate uniform definitions within tax bases, simplified audit and administrative procedures, and emerging technologies to substantially reduce the burdens of tax collection. The focus of the project is to improve sales and use tax collection and administration systems for both Main Street retailers, remote sellers, and for states. There are currently forty-two states involved in the project.

The project's main goal is to provide a sales and use tax systems that has the following characteristics:

- Neutrality – Taxability should be independent of the method of commerce used in a transaction.
- Efficiency – Administrative costs should be minimized for both business and government.
- Certainty and Simplicity – Tax rules should be clear and simple.
- Effectiveness and Fairness – Taxation systems should minimize the possibility of evasion.
- Flexibility – Taxation systems should keep pace with changes in the economy.

In January 2001, U.S. state leaders, working with more than 100 companies, unanimously adopted a model state streamlined sales and use tax legislation to remove

the burdens on business of compliance with thousands of different state and local sales tax systems. This new system proposes a 21<sup>st</sup> century, simplified tax system that would provide a single method of registration and a single means of reporting for all states, uniform rules and schedules for remittance to states, and uniform definitions of goods and services (15).

### 3.4 The European Union:

Although the US was undoubtedly the major player in e-commerce, American policy makers were not alone in their quest to define appropriate e-commerce taxation rules – Europe and other countries had equal concerns.

European Union members formally documented their own ‘plans’ for taxing Internet transactions, initially for example, in the Bonn Ministerial declaration and the European Commission’s 1997 “European Initiative in Electronic Commerce”. In the latter the principle of a “clear and neutral” tax environment was supported. However, the document clearly stated that “electronic trade in goods and services clearly falls within the scope of VAT” and pointed out that VAT would apply to the purchase of soft goods at the place of consumption.

In an extraordinary session on December 13, 2001, The EU Council of Economic and Finance Ministers met in Brussels and decided to move forward on two major tax initiatives - proposed directives on savings taxation and e-commerce VAT. On February 12, 2002 The Council reached a political agreement, on amending Regulation (EEC) 218/92 on administrative co-operation in the field of VAT and on amending the sixth Council Directive 77/388/EEC on VAT arrangements for certain services supplied by electronic means, as well as subscription-based and pay-per-view radio and television broadcasting. But these could only be formally adopted when all the language versions became available. This was done on May 7, 2002, when Council Directive 2002/38/EC was adopted. At the same time the Council adopted Council Regulation (EC)792/2002, temporarily amending Regulation 218/92 on administrative co-operation in the field of indirect taxation, to introduce additional measures necessary for the registering of foreign e-commerce traders for VAT purposes and for distributing the VAT receipts to the Member States where the services were actually used (9) (10).

The new rules aim to ensure that certain electronically delivered services are taxed at the place of consumption. They can be summarized as follows:

- Non-EU suppliers will have to charge VAT on services electronically supplied to EU customers at the VAT rate of the Member State where their customer usually resides. They can register in the Member State of their choice (so called Member State of identification) and pay all VAT due on a quarterly base. The State concerned will then re-allocate the VAT revenues to the Member States where the consumer is located. Registration will not be necessary for non-EU established traders whose

annual level of sales within the EU is below EUR 100 000.

- When these services are provided by an EU operator to a non-EU customer, the place of taxation will be where the customer is located and they will not be subject to EU VAT.
- When an EU operator provides these services to a taxable person (i.e., to another business) in another Member State, the place of supply will be the place where the customer is established.
- Where the same operator provides these services to a private individual in the EU, or to a taxable person in the same Member State, the place of supply will be where the supplier is located.

Additional measures can be summarized as follows:

- Tax on supplies to business customers will be accounted for by the customer. Registration for tax purposes will only therefore be necessary if supplies are made to private customers.
- A single place of registration (which will, in practice, normally be the Member State to where a first taxable supply is made) will be possible. This will enable the operator to discharge all obligations for EU VAT with a single administration. This latter measure effectively puts EU and non-EU operators on an equal basis when supplying to EU customers.
- It will also be possible to complete electronically all procedures in relation to registration and the making of tax returns.
- Tax administrations will provide operators with the means to distinguish easily the status of the customers (i.e. whether the customer is a VAT registered business or not) and this will normally provide the means whereby a supplier, acting with all possible diligence, can determine whether or not a transaction should be charged with tax.

Existing VAT rules for other transactions remained unchanged.

### 3.5 The OECD:

The OECD at its Turku meeting in 1997 presented its own “framework conditions” (document 25 from the Committee of Fiscal Affairs) for dealing with taxation and e-commerce. It outlined the general tax principles that should be applied to e-commerce. Specifically: neutrality; efficiency; certainty and simplicity; effectiveness and fairness; and flexibility.

Of primary concern to OECD member states was their belief that the Internet would facilitate increased cross-border commerce and increase the mobility of business and capital. Related tax administration and compliance issues were also of concern. Specifically:

- They feared the lack of any user control as to the location of the activity (vendors don’t know where their customers are, customers don’t know where their vendors are, and governments don’t know where either participant is).
- They feared being unable to identify users.

- They feared the reduced use of information reporting and withholding institutions (disintermediation).
- And, they had concerns regarding the development of electronic payment systems.

Members also believed, and were equally concerned, that tax havens and offshore banking facilities would become more accessible and, presumably, more widely used to avoid or evade tax.

Based on a consensus reached on the Taxation Framework Conditions at their Ottawa conference (October 1998), which included participation of a number of non-OECD countries, the OECD committee on fiscal Affairs (CFA) set up Technical Advisory Groups (TAGS), to produce recommendations on a variety of issues. It also issued a draft-revised commentary to article 12 of the model treaty addressing the tax treatment of software. In addition, they proposed a change to the commentary on Article 5 of its model tax convention with respect to the definition of "permanent establishment." Under this expanded definition, the presence of a server or Web page by itself generally would not satisfy the requirements for a permanent establishment. A server could be a permanent establishment if it performed significant activities that were more than "preparatory" or "auxiliary." It was left up to each member country to adopt clear and certain rules as to what would constitute significant activities for that purpose.

But their work continues! Since the agreement on the taxation Framework Conditions, the organization, through its Committee on Fiscal Affairs ("Committee"), has pursued an ambitious work program directed at effective implementation of the framework conditions. A key element of that work program has been an international dialogue, involving not only OECD member countries but also the international business community and a number of non-member economies. In March 2001, they published a progress report on the implementation of the Framework Conditions and a number of other "key documents" have emerged from that work program - on international direct tax issues, on consumption tax issues, and on tax administration issues.

On international direct tax issues:

- The full text of the agreed "Clarification on the Application of the Permanent Establishment Definition in E-Commerce: Changes to the Commentary on the Model Tax Convention on Article 5"
- The final report on "Treaty Characterization Issues Arising from E-Commerce, which was produced by the TAG (Technical Advisory Group) on Treaty Characterization of E-Commerce Payments".
- A Discussion Draft on "Attribution of Profit to a Permanent Establishment Involved in Electronic Commerce Transactions, prepared by the Business Profit TAG".
- A discussion draft on "The Impact of the Communications Revolution on the Application of "Place of Effective Management" as a Tie Breaker Rule", prepared by the Business Profits TAG.

- A report by the Business Profits TAG summarizing progress made in the context of its mandate, and proposed areas of future work.  
On consumption tax issues:
- A report by the Committee's Working Party No. 9 on Consumption Taxes: "Consumption Tax Aspects of Electronic Commerce".
- A report by the Consumption Tax TAG summarizing progress made in the context of its two-year mandate, and proposed areas of future work.
- A report by the Technology TAG summarizing, in particular, its advice on possible collection mechanism options for consumption taxes, and proposed areas of future work.  
On tax administration issues
- A report by the Committee's Forum on Strategic Management: "Tax Administration Aspects of Electronic Commerce: Responding to the Challenges and Opportunities".
- A report by the Professional Data Assessment TAG summarizing progress made in the context of its two-year mandate, and proposed areas of future work.

It is evident the OECD sees the development of appropriate Internet taxation policies as a major international issue (18).

### 3.6 The World Trade Organization:

In terms of The World Trade Organization (WTO); currently tariffs are not imposed on most electronic transactions but are normally only applied to the physical trade of goods. However, The General Agreement on Trade in Services (GATS) (22), the WTO agreement covering trade in services, does include under "Communications Services", some sub-sectors which relate to conduction of electronic commerce (including data transmission services, electronic mail, information and database retrieval, electronic data interchange, and online information and data processing – including transaction processing).

In their "Declaration on Global Electronic Commerce" adopted at the Second Session of the (Geneva) Ministerial Conference on May 20, 1998, the WTO Members agreed to establish a work programme to examine all trade-related issues relating to global electronic commerce (specifically taking into account the needs of developing countries) but, to continue their practice of not imposing customs duties on electronic transmissions. Implementation of the Work Programme was assigned to four WTO bodies, namely; the Council for Trade in Services; the Council for Trade in Goods; the Council for TRIPS; and the CTD. The General Council adopted the plan for this work programme on September 25, 1998, initiating discussions on issues of electronic commerce and trade by the Goods, Services and TRIPS (intellectual property) Councils and the Trade and Development Committee (23) (24).

The Doha Declaration resulting from the November 2001, Fourth Ministerial Conference in Doha, Qatar; endorsed the work already done by the work

program on electronic commerce sub groups and stated that the WTO members would continue their practice of not imposing customs duties on electronic transmission. The Declaration stated that members would continue this practice until the Fifth Ministerial Conference (25).

But, the organization remains divided on the question of whether to treat electronic commerce transactions and digitally delivered products as goods or services. The issue is crucial for businesses engaging in e-commerce, since it determines which multilateral trade rules and market access obligations apply to these transactions. The United States, in particular, has urged that goods delivered in digital form be classified as goods rather than services to the maximum extent possible, thus automatically making such transactions subject to the mandatory basic market access provisions of the General Agreement on Tariffs and Trade ("GATT"). In contrast, the European Union has advocated a services classification, which would only require WTO members to commit to a market access liberalization over which they have significant discretion.

### **3.7 The Industry Perspective:**

While governments strive to develop appropriate methods for taxing e-commerce (likely based on the residence of the consumer), consumers and technology vendors largely take an opposite view – no new Internet taxes.

The Internet Tax Fairness Coalition (a U.S. organization whose members include; AeA (formerly the American Electronics Association, America Online, Inc., Apple Computer, Inc., Cisco Systems, Inc., Direct Marketing Association, First Data Corporation, Information Technology Industry Council, Information Technology Association of America, Microsoft Corporation, Novell, Inc., Oracle Corporation, Software Finance and Tax Executives Council, Software & Information Industry Association, Sun Microsystems) contends that imposing additional taxes on Internet sales could severely hamper existing small and midsize resellers and retailers, and could prevent others from entering the market. They feel that interstate commerce and the economy are burdened by multiple, confusing and inconsistent state tax rules. Therefore, development of a simple and uniform system is critical. They support the following objectives for reducing the tax burdens imposed on interstate commerce that thwart the development of a borderless marketplace:

- Establish simple and uniform sales and use tax rules that reduce compliance burdens for all taxpayers.
- Enact nexus standards for business activity taxes that eliminate uncertainty and the potential for double taxation.
- Promote availability of the Internet to all by prohibiting taxes on access fees.
- Prevent multiple and discriminatory taxation by extending the application of traditional tax rules to electronic commerce.

In their letter to the of September 6, 2001 to The Finance Committee, following testimony at the August 1, 2001 Finance Committee hearing on "Cybershopping and Sales Tax: Finding the Right Mix"; they urged the Committee to move forward on the single point of consensus that emerged from the witnesses' collective testimony—that the moratorium of the Internet Tax Freedom Act ought to be extended. They made an identical plea to the US Congress suggesting, "If the ITFA moratorium is permitted to expire it will cast a chill over interstate commerce by signaling to the more than 7600 state and local taxing jurisdictions that disparate tax treatment of transactions based on the medium used is acceptable. The Internet Tax Fairness Coalition (ITFC) believes that Congress must not delay. We urge you to extend the moratorium on the imposition of these new taxes before it is too late". Their proposed draft legislation provided to extend the moratorium enacted by the Internet Tax Freedom Act through 2007, and encouraged States to develop an Internet tax regime that is simple and uniform (17).

"We're opposed to any new taxes on the Internet," says George S. Isaacson, acting director of the Association for Interactive Media (reportedly the largest Internet trade association) (12). Isaacson explains "We're working for the Amazons of the future to make sure they have the ability to grow and gain market share". In his presentation to the commission, he argued, "Information technology and electronic commerce have been the most important factors fuelling the largest and longest economic boom of this century" and warned against the negative effects of inappropriate e-commerce taxation policies (4).

However, there are more moderate and even dissenting views. Mark Negergall, president of the Software Finance and Tax Executives Council, says his group, compiled of major software providers, is neutral on taxation as long as the tax is non-discriminatory. "Our view is that we should be treated no better or worse than any other medium, such as telephone, telegraph, telefax or direct mail."

In spite of a study released by Ernst & Young (funded by the e-commerce Coalition) which challenges the notion that Internet commerce threatens to drain the treasuries of state and local governments; leadership in Silicon Valley appears to be siding with state and local governments in favor of taxing the Internet. As with other advocates for taxation, they argued that state and local governments need the potential sales tax revenues offered by on-line commerce. They suggest that failing to apply sales taxes to on-line transactions is fundamentally unfair and is a disadvantage to traditional in-store buying.

## **4. What Happens Next?**

It is clear that if electronic commerce continues to grow (especially if the growth is at the expense of conventional commerce) the question of e-commerce taxation will have to be answered both at the domestic

and international levels. The current lack of neutrality and basic fairness in e-commerce taxation legislation will become more painfully obvious (at the heart of the debate is the principle that states and other local governments have the right to tax goods sold within their jurisdiction). Consequently any future discussion on e-commerce taxation must include the following key issues:

- The proper relationship between federal and the local governments on issues of taxation, and which levels of government ought to bear the responsibility for determining and financing the needs of their citizens and businesses;
- The necessity of keeping tax policy neutral so that neither traditional retailers nor remote sellers (catalog, Internet, or similar enterprises) are given an advantage based on tax policy;
- The need to stop erosion of essential revenue streams that support education and other key public services at the local level.

And, The technical issues on the table continue to be:

- What constitutes taxable presence from the use of the Internet?
- What is the tax classification of income from electronic activities (the main consequences being the application of withholding tax and indirect taxes)?
- How are taxpayers identified and their transactions audited?
- What are the implications for transfer pricing and the use of tax havens?

The U.S. is making an effort with its Streamlined Sales Tax System for the 21<sup>st</sup> Century Project. The European Union, growing more and more concerned about the potential loss of revenue adopted new rules with regards to VAT on electronic commerce which will come into effect in July 2003. But the new directive has drawn international criticism – the OECD, Japan and the U.S. have all voiced concerns. The Commission justified making its proposals without waiting for the outcome of the OECD negotiations, saying that under the Ottawa Framework, consumption taxes such as VAT should be levied in the jurisdiction where consumption takes place, and that for those purposes, a supply of digital products should not be treated as a supply of goods. It said the new proposals would ensure that the EU VAT system conformed to the framework's principles. Commissioners also assured the U.S. and Japan that they recognized the need for international collaboration on the taxation of e-commerce, but suggested that they were particularly concerned with simplifying European VAT rules to ensure that non-EU operations were brought within their scope as soon as possible. The is growing concern however that this unilateral move by the EU could open the floodgates for other nations to impose e-commerce taxes in an uncoordinated, cost-inflicting patchwork.

The OECD continues its work and is supported by the US in their efforts to create consensus around baseline taxation rules that could undergird the international

expansion of e-commerce. The WTO will present the latest developments in its efforts to address e-commerce taxation at the Fifth Ministerial Conference.

While the debate is far from with international “saber-rattling” continuing; the EU has definitely moved the discussion up a notch with its new electronic commerce directive. Only time will tell if their new “consumption-based” directive, and its inherent administrative cost burden, is taking the e-commerce taxation issue in the right direction. If accepted by the global community this shift in emphasis in allocating taxing authority, from the supply based residency concept to the consumption based residency concept, would provide an unprecedented opportunity for developing countries to increase their tax base – particularly for those developing countries, such as China, which are experiencing astronomical growth in internet usage.

## References

- [1] The Advisory Commission on Electronic Commerce (ACEC) was created by Congress to study federal, state, local and international taxation and tariffs on transactions using the Internet and Internet access. The Commission's 19 members included three of the U.S.'s governors, heads of several major information technology corporations and other government and business leaders from across the U.S. Virginia Governor James S. Gilmore, III, chaired the Commission. (<http://www.ecommercecommission.org/about.htm>) Advisory Commission on Electronic Commerce Report to Congress, April 2000 - ([http://www.ecommercecommission.org/acec\\_report.pdf](http://www.ecommercecommission.org/acec_report.pdf))
- [2] Anonymous: E-commerce on rebound according to IMRG retail index; Marketing Week: London; May 2, 2002;
- [3] Anonymous; Mapping out e-commerce growth: The Secured Lender; New York; May/June 2002.
- [4] Brightbill, Tim; Worlton, Amy: E-Commerce Law Report, May 2002, Page 9, Vol. 4, No. 7, Pg. 9, “New Markets, New Risks: Barriers to Global Electronic Commerce”
- [5] Bruce, Donald; Fox, William; 2001, Tax Analysts, State Tax Today, August 23, 2001 “State and Local Sales Tax Revenue Losses from e-Commerce: Updated Estimates, September 1, 2001.
- [6] Clinton, William J; Gore, Albert Jr.: A Framework For Global Electronic Commerce, (<http://www.w3.org/TR/NOTE-framework-970706.html>)
- [7] The Committee On State Taxation (COST) is a nonprofit trade association based in Washington, DC. COST was formed in 1969 as an advisory committee to the Council of State Chambers of Commerce and today has an independent membership of 550 major corporations engaged in interstate and international business. COST's objective is to preserve and promote the equitable and nondiscriminatory state and local taxation of multijurisdictional business entities. <http://www.statetax.org/index.html>

- [8] esalestax.com: Proposal to Address Issues of State and Local Taxation of Internet Transactions for the Advisory Commission on Electronic.
- [9] European Union: Directive 2000/31/EC of the European Parliament and of the Council of June 8, 2000 on certain legal aspects of information society services, in particular electronic commerce, in the Internal Market (Directive on Electronic Commerce).
- [10] European Union: A European Initiative in Electronic Commerce Communication to the European Parliament, the Council, the Economic and Social Committee and the Committee of the Regions COM(97)157 (<http://www.cordis.lu/esprit/src/ecomcom.htm>)
- [11] IDC Research, (<http://www.idcresearch.com>) IDC delivers dependable, high-impact insights and advice on the future of e-business, the Internet, and technology to help our clients make sound business decisions. We forecast worldwide markets and trends and analyze business strategies, technologies, and vendors, using a combination of rigorous primary research and in-depth competitive analysis. We provide global research with local content through more than 720 analysts in 43 countries worldwide. IDC's customers comprise the world's leading IT suppliers, IT organizations, e-business companies, and the financial community.
- [12] Isaacson, George S.: Exploding Nexus Myths - Why Current Constitutional, Standards Are Fair , And Serve The National Interest, prepared for, The Advisory Commission on Electronic Commerce ([http://www.ecommercecommission.org/document/George\\_Isaacson2.doc](http://www.ecommercecommission.org/document/George_Isaacson2.doc)).
- [13] Interactive Media Retail Group, Press comment June 2, 2002 - e-retail hotspots up :([http://www.imrg.org/IMRG/press.nsf/\(httpPressReleases\)/9D2EE6E5A4DCB1A980256BEA00510CD7](http://www.imrg.org/IMRG/press.nsf/(httpPressReleases)/9D2EE6E5A4DCB1A980256BEA00510CD7))
- [14] The Internet Tax Freedom Act (formerly known as S.442, now Title XI of P.L. 105-277, the Omnibus Appropriations Act of 1998), (<http://www.ecommercecommission.org/ITFA.htm>)
- [15] Letter from Governors Parris N. Glendening and John Enbglar to The Honorable Donald Evans, Secretary U.S. Department of Commerce and the Honorable Paul O'Neill, Secretary, U. S. Department of the Treasury.
- [16] Millistein, Julian S; Neuburger, Jeffrey D.; Weingart, Jeffrey P.: Doing Business on the Internet, 2002 by Law Journal Press.
- [17] Negergal, Mark E., President, Software Finance and Tax Executives Council before the Subcommittee on Commercial and Administrative Law, Committee on the Judiciary, United States House of Representatives, June 29, 2000. Hearings on: H.R. 4267, the "Internet Tax Reform and Reduction Act of 2000"; H.R. 4460, the "Internet Tax Simplification Act of 2000"; H.R. 4462, the "Fair and Equitable Interstate Tax Compact Simplification Act of 2000" ([http://www.softwarefinance.org/policy/tax/judtest6\\_00.doc](http://www.softwarefinance.org/policy/tax/judtest6_00.doc))
- [18] OECD; Electronic Commerce: Taxation Framework Conditions. A report by the Committee on Fiscal Affairs as presented to Ministers at the OECD Ministerial Conference, "A Borderless World: Realizing the Potential of Electronic Commerce" on 8 October 1998. (<http://www.oecd.org/pdf/M000015000/M00015517.pdf>) OECD, Taxation Aspects of Electronic Commerce, Publication of Reports and Technical Papers (<http://www.oecd.org/EN/document/0,,EN-document101-3-no-4-1564-101,00.html>)
- <http://www.oecd.org/pdf/M000015000/M00015535.pdf>
- <http://www.oecd.org/pdf/M000015000/M00015536.pdf>
- <http://www.oecd.org/pdf/M000015000/M00015525.pdf>
- <http://www.oecd.org/pdf/M000015000/M00015526.pdf>
- <http://www.oecd.org/pdf/M000015000/M00015527.pdf>
- <http://www.oecd.org/pdf/M00022000/M00022378.pdf>
- <http://www.oecd.org/pdf/M000015000/M00015515.pdf>
- <http://www.oecd.org/pdf/M000015000/M00015516.pdf>
- <http://www.oecd.org/pdf/M000015000/M00015520.pdf>
- <http://www.oecd.org/pdf/M000015000/M00015523.pdf>
- [19] Shafroth, Frank, NGA Director of State-Federal Relations, before the Senate Finance Committee on Tax Equity and Sovereignty for States in the Digital Age, August 1, 2001.
- [20] US Census Bureau, Depart. of Commerce (<http://www.census.gov/mrts/www/current.html>).
- [21] U.S. Tax Code Online, <http://www.fourmilab.ch/ustax/ustax.html>.
- [22] WTO - The agreement on trade in services reached in the Uruguay Round is perhaps the most important single development in the multilateral trading system since the GATT itself came into effect in 1948. The new General Agreement on Trade in Services (GATS) for the first time extends internationally agreed rules and commitments, broadly comparable with those of the GATT, into a huge and still rapidly growing area of international trade. Although reliable statistics on services are few, conventionally measured trade in services is generally agreed to be equivalent in value to about one-quarter of international trade in goods. World Trade Organization, General Agreement on Trade in Services, April 1994. ([http://www.wto.org/wto/english/tratop\\_e/serv\\_e/gatsintr\\_e.htm](http://www.wto.org/wto/english/tratop_e/serv_e/gatsintr_e.htm))
- ([http://www.wto.org/wto/english/tratop\\_e/serv\\_e/gsintr\\_e.doc](http://www.wto.org/wto/english/tratop_e/serv_e/gsintr_e.doc))
- [23] World Trade Organization: WT/MIN(98)/DEC/2, 25 May 1998, (98-2148), Ministerial Conference, Second Session, Geneva, 18 and 20 May 1998, Declaration on Global Electronic Commerce, Adopted on 20 May 1998.
- [24] World Trade Organization: Restricted G/C/W/128, 5 November 1998, (98-4330), Council for Trade in Goods, Work Programme on Electronic Commerce.
- [25] World Trade Organization: DOHA WTO MINISTERIAL 2001: MINISTERIAL DECLARATION, WT/MIN(01)/DEC/1, 20 November 2001, Ministerial declaration, Adopted on 14 November 2001 ([http://www.wto.org/wto/english/tratop\\_e/dda\\_e/dohaexplained\\_e.htm](http://www.wto.org/wto/english/tratop_e/dda_e/dohaexplained_e.htm))

# The Systematic Thinking on the Development of Chinese E-Business

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## Abstract

This thesis systematically analyses the concept of e-business, its components, e-business technology environment and society environment. It especially lays emphasis on the importance of the combination of e-business and the internal informationization of enterprises and e-business society environment. Based on them, the thesis further makes systematic analysis on the main problems existing inside enterprises and the problems of its environment during the development of e-business. Next it points out that e-business has been prevented from developing mainly by inner informationization and society environment. At last the thesis proposes the countermeasures for the development of e-business.

## 1. Introduction

E-business (EB) embodies the close combination of the latest science and technology and production and management. It means not only their continual and wide combination, but also the market's return to technology and its impetus to it. As a result of it, the efficiency of production and management must be raised and resources must be distributed reasonably. E-business embodies many scientific new ideas, which represent the most advanced ideas of the human development.

What's more, the essential idea and value lie in its overcoming the limit to the freedom, to the district, to the time, to the communication and to the cooperation. In addition to these advantages, e-business is also the advanced form of business, which embodies the inevitable tendency of its development in that such characteristics as unlimited areas, low cost, personalized product and service, high efficiency, sufficient information, manpower and material resources distributing all over the world are just the requirements of e-business itself. Therefore, e-business is the business form with a broad prospect.

To china, e-business is only in the initial stage and there lies much difference whether in scale, management model, coverage and ideas compared with the developed countries. In addition, the special Chinese market environment also brings about the special e-business activities. Chinese economic system innovation is in the crucial period: the traditional means of planning is fading and the market mechanism is not yet sound. When enterprises enter market, they also must enter the market of e-business. E-business is a complicated systematic project, involving the systematic management of computer information, finance settlement and the enactment of law

regulations, etc.

It needs organizing and harmonizing by the powerful institution with cross-department and cross-district. And the thesis makes a systematic analysis on Chinese e-business in order to reach some beneficial conclusions, which presents the following sections. The second section discusses the concept of e-business. The third section analyzes e-business systematically. While the fourth one presents the problems and its reasons for them in the development of e-business. On the basis of the research, countermeasures make the fifth section. At last, the thesis draws some conclusions.

## 2. The Signification of E-business

### 2.1 The Process of E-business Development

So far e-business has experienced two stages. The first stage was during the late 1960s and the early 1980s, whose core was e-trade based on EDI. And we call this stage **traditional e-commerce**. However, the system of EDI was deficient in flexibility and the components of the system were expensive and its usage was only limited to customer-merchant, while the end-customer was exclusive from it.

When e-business was based on EDI, Intranet and web sites came into being; it was immediately widely identified and was performed with surprising speed. Thus it came into the second stage of e-business and we call it **modern e-business stage**. During this stage, e-business developed quickly with such characteristics it possesses as its openness, cheapness and globalization.

But recently the development of e-business has been covered by the shadow of a tendency of web-sites breaking down. So we think the present e-business is not perfect and needs to be further studied. The future e-business is a complete e-business with enterprises centered, containing all the management activities and we call it **mature e-business**. And then is the third stage of e-business.

### 2.2 The Concept of E-business

There are many concepts concerned e-business, such as e-commerce, Internet marketing and e-business, etc. All these concepts refer to the bargaining on the Internet. That is to say, the core of e-business is "business" and "electron" is the means of e-business. But at the same time, e-business not only simply refers to the transaction on Internet, but also contains internal informationization of enterprises. The informationization is the background

support of e-business and is also the very important part of e-business. Thus, e-business is not only the patent of such new Internet companies as Sohu and Sina. What is more, it is combined with traditional industries. Traditional industries have accumulated advantages of all aspects for a long time and it has laid a solid foundation for e-business and it is the main field where e-business is applied. Only all various industries involved in it will e-business have a broad prospect. To say exactly, e-business has two meanings from two aspects. In the narrow sense, e-business is business and transaction through Internet or what we call electronic commerce (EC). While in the wide sense, e-business refers to the whole business activities that have been electronized by the technology of IT. The latter will take advantage of various forms of network, among which there are Internet, Intranet and local area network and so on.. The comparison between e-business and e-commerce sees the following table 1.[1]

**Table 1 The comparison between EB and EC**

	EB	EC
<b>Technology</b>	Web	Web + IT
<b>E-business activities</b>	Internet trade	Internet trade + business

### 3. The Systematic Analysis of E-business

#### 3.1 The Structure of E-business System

E-business is a complicated system, having systematic traits. System that is made up of numerous interrelated elements is an organic entirety having special functions and it has many characteristics, such as collectiveness, stratification, relativity, entirety and environmental adaptability, etc. E-Business as a system also has such characteristics. So the research on e-business must be led by the systematic thought to study its factors and its interrelation. And according to it, we in the end establish the systematic model. See figure.1.

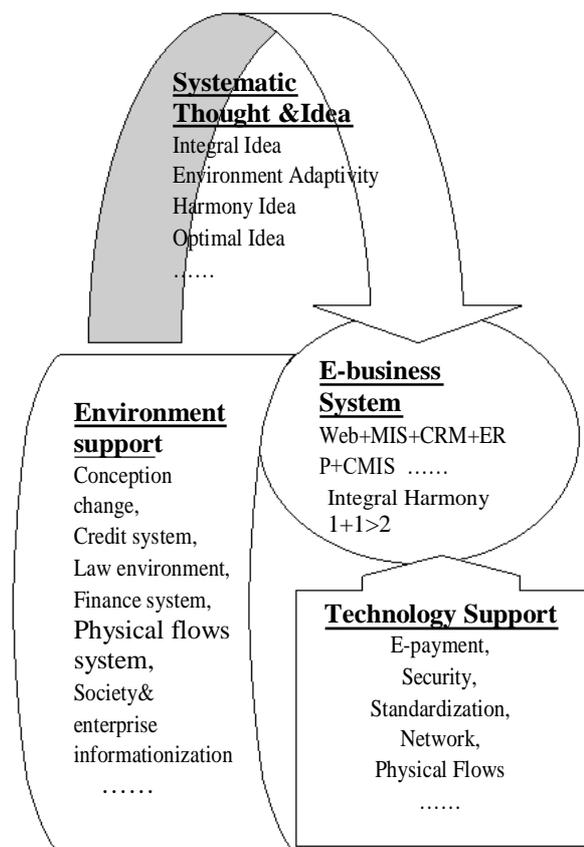
From the figure, we can see e-business, as a system, on one hand, contains downstage e-trade system for external, which we call e-shop. On the other hand, e-business, as a system, can't exist without the support of every department and every tache of enterprises, which we call background support system. The informationization and efficiency of all these departments and taches have direct influence on the normal course of e-shop. Among the background support system, there are MIS, CMIS, ERP, CAD, and CRM etc. Only under high degree of internal informationization of enterprises does high quality e-commerce exist.

Therefore, The e-business system is reasonably divided into three function modules: content management, collaboration, commerce service is reasonable.[1]

##### 3.1.1 Content Management

Content management means the management of issuing various information on Internet. It mainly contains managing and classifying the information of enterprises;

issuing and updating information on Web; providing with the information concerned products and service; helping



**Fig. 1 E-business system and its environment**

transmit internal information of enterprises. To say exactly, by Internet, the policies and notices of enterprises are transmitted to staff, customers and business partners. Thus by such management, information is used fully to increase the value of brand names and enlarge the influence of enterprises.

##### 3.1.2 Collaboration

Collaboration helps to cooperate departments and operation taches. By the automatically operated flow, the cost of operation is lowered and the period of product exploitation is shortened. Concretely it includes the collaboration of intranet and the collaboration of extranet. The latter refers to collaborating inner resources of enterprises, among which there are manpower resources, capital, equipment and material, etc. Intranet connects all departments and operation taches. Extranet connects providers and business partners and so on.

##### 3.1.3 Commerce Service

Commerce service is mainly used to perform

transaction on Internet and provide services of pretransaction, of during transaction and of posttransaction. It can mainly serve the following functions: provide products and service lists; deal with order form; sign transaction contract; perform e-payment and provide after service.

### 3. 2 The Harmony in E-business System

As a system, the coordination of inner elements is the key to producing the best effect on the whole. If the elements have good interrelations, the good system structure will be established and then the good function will be able to be performed. ERP, CRM etc are the most important parts of the informationization inside enterprises, which support e-business. It is hard to imagine that an enterprise with lagging manual management can perform e-business well. In the meanwhile, e-payment system, e-authentication system and safety guard system are also very important parts of e-business. The optimal integration of these subsystems is the key to making the best e-business operation.

#### 3.2.1 The Integration of ERP and EC

ERP mainly focuses on the internal flow of enterprises, while the focus of EC is external transaction. The management model of enterprises before their integration is as follows: receiving order form on website, but goods stocking and collocating and delivering are performed in a traditional way. What we call purchase online is a simple form of EC. The efficiency of its background function is still very low. The process of transaction on the whole is broken and out of joint. By virtue of the technology of Intranet, Extranet and Internet, enterprises fulfill the integration of ERP and EC. In addition, they realize the integration from customers to providers and that of internal flow of enterprises.

#### 3.2.2 The Integration of ERP and CRM Based on EC

CRM is a suit of management ideas and also a suit of practical ideas based on Internet. By recombining operation flow of enterprises, CRM integrates user information resources in order to manage client resources in the effective way and provide clients with more economic, shortcut and circumspect products and service and finally to maximize the profit of enterprises. On the base of modern information technology, CRM can furthest satisfy the individual needs of clients so as to retain old clients and attract new clients, which is enterprises' magic weapon to win. Now enterprises attach more and more importance to CRM.

In the competing environment of EC, enterprises, on one hand need quick and flexible production model and take advantage of ERP to fulfill it. On the other hand, they need to realize the market model of individuation service and CRM serves this purpose. CRM and ERP support each other and depend each other and their relationship is that of transmitting of data information. First of all, ERP

provides CRM with rich data. Next, CRM provides ERP with decision-making data by analyzing and forecasting market development. Only if ERP and CRM are integrated with EC is the transaction model on line realized. And it is the modern EC model. In this model, internal flow of enterprises integrates with external transaction. CRM makes a mutual marketing with clients and ERP makes the data flow on the supply chain fluent. CRM and ERP make enterprises powerful and gain more profit in different ways. The former is used to ease the relationship between customers and clients, while the latter is used to optimize the production flow of enterprises. EC is the reflection of the achievements of ERP and CRM. Consequently it is an integral "end to end" EC with "customer centered"

### 3. 3 The Environment Analysis of E-business

Environment consciousness or environment idea is also very important content of systematic thought. Environment analysis is an essential link in systematic analysis. And environment is also systematic, which we call environment super-system. Environment plays two reverse roles in system. On one hand, it supplies such favorable conditions with the space of survival and development, sustentation of resources and infrastructure and so on. On the other hand, it will exert a passive influence on system development, like exerting restriction, disturbance and pressure, etc. Thus environment plays an important part in e-business development.

From the figure, we can see that the environment of e-business mainly consists of two parts: **technology -support environment** and **social environment**. EB cannot develop without the support of technology. The development of related technology is the precondition and the safeguard of successful EC development. Only perfect technology can be the safeguard for transaction. The technology mainly concludes Internet technology, safety technology, payment technology, and standardization technology, physical flow technology, etc. These technologies provide technology support for e-business.

To say exactly, there is no e-business without corresponding technology safeguard. Among these technologies, we attach importance to the security of safeguard, authentication technology, e-payment technology and standardization technology, etc. Security technology is centered among them, concerning data signature technology, identity authentication technology and encryption techniques, etc. Payment technology relating to capital transfer and settlement, is also concerned by people. It means the problem of capital security and the convenience of payment. The standardization of the related technology of EC is a key problem. Criteria can make the products and service provided by manufacturers interchange and mutually operate. Furthermore, they can normalize market participants' behavior and encourage competition and decrease the risk. By the way, standardization involves the standardization of contract text, that of EC technology, that of e-payment and that of ECM, etc.

E-business is in a complicated social environment. And the environment concerns many aspects, such as law, the construction of credit system, the level of society informationization and that of enterprise informationization and the informationization of finance system and that of physical flows, etc. The appropriate social environment is an important support for EC success. Social environment is the soil on which e-business develops

#### **4. The Chinese Problems Existing in the Development of E-business**

The development of e-business exists great difference between China and developed countries. In contrast, Chinese e-business has its own specialties. Generally speaking, the following problems have to be solved in the development of e-business.

##### **4.1 The Inner Problems of Enterprises**

Inside enterprises, the degree of informationization is low. The degree of informationization of large enterprises on the whole is very low. According to the research on 638 key enterprises of our country, there are 48 and 7.5% enterprises that have completely realized the information system of basic management, containing OA, MIS systems and so on; there are a half and 59.9% enterprises that have partly realized it; there are 208 and 32.6% enterprises that have not realized it. While there are 30 and 4.7% enterprises that have completely realized the comprehensive information system of management, containing CIMS and ERP, etc; there are 30.7% enterprises that have partly realized it; there are 412 and 64.6% enterprises that haven't set about it. Besides, there are 8 and 1.2% enterprises that have basically used e-business; there are 482 and 75.5% enterprises that haven't started. Though there are 435 and 68.2% enterprises have established websites, only 117 (18.3%) enterprises change information per week and only 139 (21.8%) ones operate e-business and their total sales are 0.1%, which are the business income of 638 enterprises in the year of 2000. [2]

Such low informationization has greatly restrained e-business from developing. Next, because e-business has not been combined with the strategy of enterprise development and the strategy cannot adapt to the development of e-business well, traditional business model of enterprises cannot obviously adapt to e-business. These are the main factors that prevent e-business from developing. In addition, the factors that ideas hang behind, sincerity and credit widely lack, the means of management fall behind and the groundwork is weak have influenced the performance of e-business in some degree.

##### **4.2 The Social Environmental Problems**

First of all, the degree of informationization in the whole society is low and Internet doesn't widely spread.

Secondly, the credit system of socialization is not

perfect and the credit degree of society is low. At present, our credit institutions of enterprises have not yet established and that no credit exists in enterprises is in fashion. Thus the problem of enterprise credit has prevented e-business from developing.

The third is the problem of system. The present system of management is basically the offspring of planning economy period, which is stick-block division, the setup is not reasonable, the cooperation is not enough, the rate of work is low and the adaptability to the new economy is weak. To start with the finance system, the e-business needs such means of finance as payment and settlement to support. So e-business is in great need of the service of finance with hi-quality and hi-efficiency and the cooperation of its electronization. Next is the safe authentication system. Now the system is in disorder and it is hard for authentication to be uniform, which keeps e-business from developing.

Fourthly, the modern degree of physical flows is very low and there are short of commerce automatization, informationization, transfer of physical flows and supply chain system to match with. The development of Chinese physical flows starts late and its degree is very low. Thus the present physical flows system restricts e-business in large degree. For instance, our understanding of e-business is limited to the electronization of information flow, commerce flow and capital flow and we ignore the process of physical flows automatization; the infrastructure of physical flows is not perfect; the technology of physical flows management falls behind; the traditional storage and convey system and its means prevent modern physical flows from developing; the third-party service lags; the physical flows system adaptive to e-business has not been established.

The fifth is the problem of law. The legislation of e-business has a long way to go. Now the law environment cannot meet the needs of e-business. Especially, the legislation of electron signature, the protect of knowledge right and the construction of safe authentication system, etc. seriously falls behind, which keep e-business from developing.

#### **5. The countermeasures of Chinese EB Development**

E-business development is a systematic engineering. It cannot ensure e-business to develop soundly by solving only one aspect of problems. E-business system in all directions must be established, which is web-based, business-centered and is supported by good environment and reliable technology.

##### **5.1 Update the Concepts of Enterprises and Strengthen the Construction of Information System of Enterprises to Improve the Informationization of Enterprises**

Try to reinforce the policy-makers' sense of urgency and responsibility, to establish the information work system with the chief information officer (CIO)-centered,

to set up the integral project and technology scheme, and to make preparation for capital, technology and manpower. Besides, try to sort out the inner resources of enterprises and realize the informationization of basic management, research and exploitation according to the requirements of inner resources management of enterprises.

To connect the following links, such as research and exploitation, production, supply, marketing and service, etc. in virtue of ERP, CRM. And try to optimize the resources of manpower, financial resources, material resources and technology, etc. Try to set up the proper e-business model and to make strategies for the development of e-business actively according to different enterprises, in order to put e-business into enterprise system, to make the components of enterprises to collaborate and finally to exert the predominance of integrity.

## **5.2 Strengthen the Environmental Construction to Create the Feasible E-business Environment**

First of all, energetically raise the level of society informationization, quicken the construction of network infrastructure, extend the coverage of network and widen the capacity of e-business marketing.

Then, hasten the construction of credit system and law environment. Credit is the key to the development of e-business. It concerns three aspects: government credit, enterprise credit and personal credit, among which government credit is a guarantee and personal credit is base and enterprise credit is the emphasis. If we want to make the construction of credit better, we must make a medium agency play its role and make credit system perfect as fast as possible.[3][6] At last, perfect the corresponding standard system, security technology and payment technology to provide e-business with technology.[4]

In the meanwhile, the good law environment can ensure e-business to develop continuously and will make e-trade uniform and confirmative in law, no matter the trade is done in the same country or in the trans-nations. Try to issue law regulations that are explicit, collective and recognizable by local, country and international law authorities. At present, what is most important is to make early the rules of law involved the activities of e-business.

The law and rules of law contains the following items: the first is the law concerning time, place and signature of signing contracts and the contract original and the law position of e-bill and the acceptability as lawsuit.

The second is the effectiveness system of e-signature which refers to the applicable scope and the ascription of e-signature and also the usage and effectiveness of e-signature, etc.

The third is about the supervision system of e-business. The finance supervision department must strengthen the supervision of e-transaction to establish the branches of issuing e-money, to make certain of the limits of its power and responsibility and to make corresponding crackdown measures and to make law of preventing cybercrimes.

The fourth is to establish the uniform principle of taxation and the jurisdiction. In addition, the construction of Chinese legal system of EB attends actively International interlocution and tries to make Chinese code accepted by International. By applying the code, Chinese e-business will be provided with strong legal safeguard and be made to further develop. [5]

## **5.3 Actively Push the Construction of Physical Flows System**

Physical flow is the main bottleneck of EB. The problem can be solved in the following ways:

### **5.3.1 Socialize Physical Flows**

The socialization of physical flow can make the disperse physical flows uniform by distributing physical flows reasonably, which can make physical flows become industry and can produce the scale efficiency. The key to realizing the socialization of physical flows is to build physical flow center adaptive to e-business.

### **5.3.2 The Informationization of Physical Flows**

It means the informationization of collecting, processing, transferring and storing of physical flows information. Such technology as that of bar code, of database, of e-order system, and EDI, etc, will be applied widely in physical flows.

### **5.3.3 The Automatization of Physical Flows**

The automatization adopts such system of physical flow automatization as automatic identity system, automatic choice system and automatic storing and taking system and so on. It can save manpower, strengthen the capability of physical flow operation and enhance the efficiency of it.

### **5.3.4 The Network of Physical Flows**

It refers to the uniform layout of physical flow system. When making a plan designing the amount, the place and the scale of physical flow center in a certain field, we must consider the plan of transaction, the range of accommodating and its scale. Besides, we must actively adopt the advanced transportation means and tools, scientific dispatching technology of physical flow to reduce overstocking in transportation.

## **5.4 Hasten to Produce Talents of EB**

The operation of EB is a complicated system engineering, which involves all aspects of society. For instance, it concerns the construction of information infrastructure and that of standardization. In addition, it is concerned with trade, customers, bank, revenue, traffic and transportation, etc. Thus EB needs not only a great number of talents of technology, and talents with all kinds of application, but also talents of management in all layers.

Consequently, we should train the persons concerned in the respect of the consciousness of EB, the knowledge and theory of layout and decision-making. For the development of Chinese EB, we should cultivate numbers of the persons not only knowing the management, but also applying the technology of EB, who can engage in the building, applying and managing EB system.

### **5.5 Reform Finance System, Promote Finance Informationization to Solve the Bottleneck of E-payment**

Finance system is the key factor to e-payment. First of all, in order to create an appropriate finance environment, we must strive to hasten the finance system reform and strengthen the cooperation of banks. Secondly, we must take an active part in financial innovation, improve the financial service and produce continually financial products adaptive to e-payment. Thirdly, promote the informationization of finance system, solve the problems of security and payment and encourage to construct the network banks. At last, we must establish the financial credit system and improve the credit degree of banks, enterprises and persons to reduce the financial risk.

## **6. Conclusion**

With the globalization of economy and the quick development of information technology and information industry, e-business will become the most popular and most active information trade activities and will become the most focused field that every country and every department of industry will strive to be the first to develop.

Chinese e-business is still in the initial stage, faced with many problems from system, technology and management, etc. But China has moved the first delightful step. E-business is a complicated system. So the research on e-business must be led by the systematic thought and we must perform research on soft environment and inner informationization of enterprises. Try to get each element in line according to the principle of integral optimization and at the same time to improve the quality of each element to put e-business practically into enterprises' strategy.

In addition, we must regard environment as a systematic engineering in the construction of environment to create favorable environment support in all aspects for e-business development.

## **Reference**

- [1] Qiming, *Practical Courses of e-business*, Higher Education Press 2000.7
- [2] Song Xilin, "The Degree of Informationization of Our Country's Large Enterprises on the Whole is not Optimistic," *China Enterprise Journal* 2002.7.23
- [3] Guoyu, "The Situation of Enterprise Credit is not Optimistic", *Beijing Morning* 2002.9.20
- [4] Yu Jianhua, "The Standardization of Management is the First Thing of Informationization of Enterprises," *Economy Journal*, 2001.5.22

[5] Li Yunzhi, "The Problems Confronting the Development of e-business and Exploration of its Countermeasures," *Economy of Commerce and Trade*, 2002.3

[6] Zouwei, Wu Zhiwen, "Analysis of Establishing and Perfecting the Credit System of Enterprises," *Finance and Insurance*, 2002.7

[7] Guanxin, "The Tendency of American e-business (previous)," *Outlook on Global Science and Technology and Economy*, 2002.10

[8] Wu Xiaosong, "The Existing Condition of Chinese e-business in the Times of New Economy and its Prospect," *Economy of Commerce and Trade*, 2001.10

# A New Business Model of Electronic Commerce with Innovative Strategies

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## Abstract

There are a lot of problems that make the business of electronic stores very difficult, especially for those firms that lack the required expertise and resources for running an electronic business. This study proposes a new business model of electronic commerce (EC), which aims to tackle those problems and help enterprises run electronic stores well. This model applies the franchise system of chain store, a very successful modern business model, to the management of electronic stores to take advantage of the chain's competitive power by integrating individual affiliate sites as a whole. There are eight components in the model. Implementation strategies of the model, which are quite different from those generic strategies commonly used in implementing business models, are also proposed. The feasibility of the model and its implementation strategies were validated using the Nominal Group Technique (NGT), the case study, and the questionnaire survey approaches. Finally, practical implications for applying the model are discussed, and directions for further study are also suggested.

**Keyword:** electronic commerce (EC), business model, strategy, electronic store, franchise.

## 1. Introduction

There have been many current organizations and new investors running electronic commerce in recent years. Various business models have been invented. However,

very rarely have successful cases been reported to date. "Direct-to-consumer" is one of the most popular EC models[20]. Dell computer is a very successful example of this model that has a positive return on its investment. Amazon.com, the largest Internet bookstore in the world, is another good example of the model. Its business model is very successful and has increased its sales very quickly. But it has not broken even yet even though its sales volume is expected to grow in the next few years. Electronic stores are very important applications of the model because they really benefit consumers and also give enterprises an additional channel to expand their business. Unfortunately, a great many electronic stores fail to survive.

There are many reasons for the failure of an electronic business. Huang and Dai[8] argued that enterprises couldn't generate a return quickly on their EC investments. As a result, a number of electronic businesses close because they cannot continue to sustain big losses over a long period. For many electronic stores, they cannot survive simply because they don't know how to manage the new business. However, most of the failures of electronic businesses are due to a lack of strategies that can fit their business models and thus can sustain a competitive advantage. The business model under the EC environment is quite different from traditional ones because of the unique characteristics of electronic businesses. It is therefore essential for

electronic businesses to have innovative strategies, which can be properly integrated with their EC models and help the models be successfully implemented, such that these businesses can gain a good stance in the drastically changing and severely competitive new market.

Business models and innovative strategies are very important EC issues. A good business model is the key to success for an electronic business. However, a good business model without proper strategies cannot assure its successful implementation. Although much research has been conducted on EC models and strategies, an important issue, the integration of innovative strategies with the EC model for its successful implementation, has been neglected. This study attempts to investigate the issue by reviewing current EC models and strategies and proposing a new EC model with innovative implementation strategies. The new model applies the franchise system, which has been successfully implemented in physical stores for several decades, to the management of electronic stores and is aimed at helping current electronic stores or those who are interested in running electronic stores to have greater competitive advantage in the industry.

## 2. Literature review

Many things need to be taken into consideration when running an electronic business. Kalakota and Whinston [10] proposed several of them: product/content, software interface, work flow, price, payment, and market penetration. Those are all essential issues that should be included in the business model of EC. EC models have to deal with the interactions between enterprises and consumers. Treese and Stewart[19] presented a framework of the businesses' value chain of EC regarding their interactions with customers. The framework includes four phases: attracting customers, interacting with customers, processing customers' orders, and responding to customers' questions. The idea of the value chain is like that of traditional management, but its execution needs an innovative method to adapt to the computer network, which is a new media for the business transaction.

EC will give rise to new kinds of business models, which can be categorized in different ways [16]. For instance, according to Weill and Vitale [20], there are models for direct to customer, full-service provider, whole of enterprise, portals, agents, auctions, aggregators, shared infrastructure, virtual community, value net integrator, and content provider situations. Yu[22] summarized current EC models and classified them into six categories in terms of transaction subjects, web services, electronic markets, economic benefits, selling contents, and specific applications. Deitel et al.[6] reviewed some practically important business models of EC. They are the storefront model, the auction model, the portal model, the dynamic-pricing model, the B2B model, and the click-and-mortar business.

The integration of EC models with implementation strategies is important to EC success. Some studies found that the high connectedness of information strategy and

business strategy is helpful to achieve better business performance [18][14]. Since the business model of an EC firm is inseparable from the firm's business strategy, and implementation strategies of the EC model are partly dependent on the firm's information strategy, it is therefore crucial to integrate the model with its implementation strategies when implementing the EC model. A good match of the EC model with the implementation strategy will align them toward the enterprise's business strategy and information strategy. As a result, this may lead to better performance.

Several factors are critical to the success of the electronic store. Cheng[4], and Lin and Chuang[15], proposed some of these factors: rich information content, plenty of products and services with the related information, good corporate image, sufficient bandwidth, secure transaction environment, reliable host computer with enough capacity, and comprehensive back-end management system. All these factors are important in running an electronic store. However, these are not enough. Actually, consumers usually demand more; they demand electronic stores to be complete and operative which provides high-quality services. Most of current electronic stores don't run well because they cannot meet the demand of customers. Accordingly, the establishment of an electronic store should be targeted to meet consumers' demand.

There are three approaches to constructing an electronic store: renting a virtual host machine from the Internet service providers, joining in an electronic mall, and developing a web site by internal staff [7]. No matter what approach is adopted, to run an electronic store effectively needs five main functions: the communication function, the product marketing function, the linkage function, the function of online ordering and payment fulfilling, and the customer relations function[17]. These functions together with the above-mentioned important factors will be integrated into the new model of franchise electronic store of this study.

The study will apply the franchise system, which has been successfully implemented in physical stores for several decades, to the management of electronic stores. A franchise is a special type of chain store or chain business in which the franchise offers affiliates the license and the brand to run a store or a business under the authorization of the franchise [9][13][5]. The franchise will give affiliates directions and support in activities of organization, training, purchasing, and management. Affiliates have to pay royalties to the franchise and run their chain businesses by following the management system of the franchise. In addition, Lee[12] argued that all affiliates in a chain should be consistent in business ideas, business identifications, products and services, and management system so that the chain can be successful.

The franchise system gives the advantages of large scale and reduces business risks for small enterprises [2]. Accordingly, they would like to join the franchise system as affiliates, even though they would lose some autonomy, in order to obtain assistance and support, and benefits of professional management and brand value. The

performance of the franchise certainly will affect the realization of the potential advantages of a franchise system. Good relationships between the franchise and its affiliates will have a positive effect on the marketing performance of the franchise[3]. The relationship is usually dependent on the content and the execution of franchising contract. In the contract, the primary issue is the economic interaction between the franchise and its affiliates. According to Woll [21], the initial sources of income for the franchise are franchise fee, royalty, rent, equipment lease, material supply, and product selling, and these items concerning money are also the key parts of the contract. Bacus et al[1] argued that factors of determining the royalty and other base fees that will be designated in the contract are characteristics of the industry and the franchise, which include the duration, the brand value, the market share, the number of employee, and the provision of services of the franchise. Lafontaine and Kaufmann[11] found that some franchises do not

charge their affiliates for initial fees of royalties and other fixed charges but collect royalties and other fees from them according to their sales volume. The above-mentioned issues of marketing and operations under the circumstance of the franchise electronic store will be further analyzed and their feasible strategies will be included in the new model of this study.

### 3. Methodology

The study developed a conceptual framework for a new EC model after reviewing the literature related to business models and innovative strategies for EC. To validate the appropriateness and the comprehensiveness of the new concept, three methods were used consecutively for enhancing it: the Nominal Group Technique (NGT), the case study, and the questionnaire survey. The research process is illustrated as Figure 1.

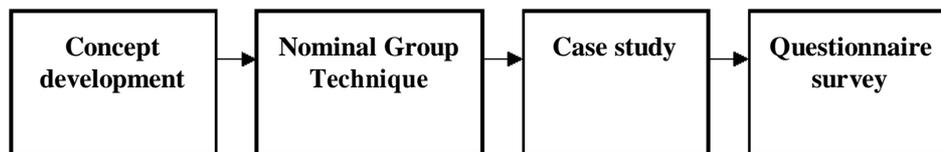


Figure 1 The research process of the study

In the stage of concept development, the study examined the related factors that need to be taken into consideration in building up a franchise system for electronic stores by analyzing the business models of the electronic store and the franchise, and then proposes a franchise model for electronic stores. After the stage of concept development, the NGT method was used to validate the proposed conceptual model. There were four persons in the study's NGT discussion group. Three were EC practitioners who are knowledgeable about the franchise system. The other one was a professor with EC as his main research and teaching interests. This group evaluated the feasibility of the conceptual model and selected the best alternative strategies for implementing the model by following the NGT's designated procedure.

After the validation by NGT, the case study method was used to enhance the model from the practical point of view. According to features of the franchise in the new model, chain stores, IT firms, and electronic malls are the most likely industries to establish the franchise system of electronic stores, so four famous electronic stores with such industry background were chosen as the study's subjects. Business models of these cases were studied and their managers were interviewed to validate the practical feasibility of the study's proposed model. Little adjustment was made to the model and its implementation strategies according to the results of case study. The model was then completed.

In the last stage, the study conducted a questionnaire survey in Taiwan for analyzing the feasibility of the new

model. Since, besides consumers, there are two main subjects related to the model: the franchise and affiliates, subjects of the questionnaire survey were potential franchisees and affiliates of the franchise electronic store. As mentioned before, potential franchises include chain stores, IT firms, and electronic malls. All enterprises in the name lists of these three industries were the population of the survey. In order to receive at least fifteen responses for the analysis at an anticipated response rate of about ten percent, one hundred and fifty questionnaires were mailed. These companies were selected by using purposive sampling method. On the other hand, the survey of affiliates was targeted at current electronic stores and those small manufacturing companies that possibly run electronic stores. Similarly, one hundred and fifty of these two types of companies were chosen by purposive sampling method as survey subjects. The questionnaires were sent to the managers of EC department, or information department if there was no EC department, of those subject companies. The questionnaire inquired about a respondent's perception of the feasibility of the franchise model of the electronic store and the appropriateness of alternative implementation strategies of this model. A five-point Likert scale was used to measure the respondent's perception except for some open questions about the respondent's basic information and comments, such as: his or her professional background and correspondence, and suggestions for the model and its implementation strategies.

## 4. A new EC model with innovative strategies

### 4.1 The new model

This study proposes a new model for electronic stores. The new model applies the franchise system to operations of electronic stores and can integrate all stores as a whole to take advantage of the effect of synergy. This new model includes a franchise website, affiliated websites, and the franchise system that support all the operations and management of the franchise electronic store. The framework can be illustrated as Figure 2. There are two main subjects, besides consumers, related to the model: the franchise and affiliates. The franchise must establish its website as a portal site for customers to enter the franchise electronic store. In addition to that, it has to help its affiliates to build up their own websites that can be linked to and integrated with the franchise website. Moreover, and which is also the most important, the franchise must have a franchise system specifying how operational and management activities of the franchise electronic store should be proceeded and assuring that affiliate stores can operate consistently and effectively. On the other hand, affiliates will join the franchise if they can gain sufficient support in those aspects they need. However, they need to run their electronic stores by following the regulations of the franchising contract so that the franchise electronic store can give a good and consistent image to customers.

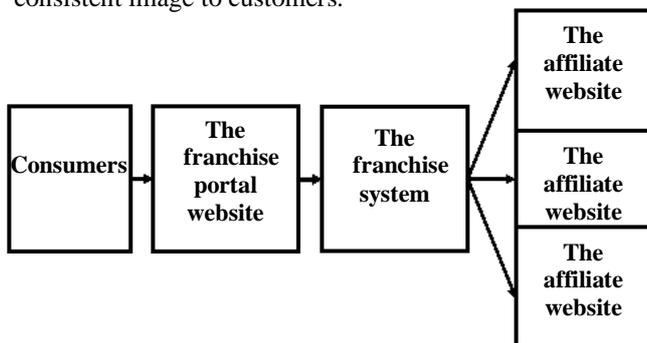


Figure 2 The framework of the new model

In the new model, a franchise system of electronic stores shall be established with respect to technology, operations, and marketing. From the dimension of technology, the model provides three components for the franchise system: the integrated portal website with the personalized technology, the technical support for affiliated websites, and the operations system of the franchise electronic store. First, the integrated portal website is very important in the new model. It is a customer portal built by the franchise, which is dynamically linked with affiliates' websites. By applying the personalized web technology and business identification system in its design, the portal site can meet the individual demand of customers and maintain a consistent image of the entire franchise electronic store. Next, the technical support for affiliated websites is also essential in the system because potential affiliates of the franchise are targeted to those firms that lack the professional staff of web technology. This component can

provide affiliates with necessary technical support and service for establishing their websites and maintaining operations of websites. Last, the operations system of the franchise electronic store is core component of the franchise system. It integrates all activities of transaction flow, material flow, payment flow, and information flow among the franchise, affiliates, and customers and offer efficient franchise operations.

From the dimension of operations, the model offers three components to the franchise system: the integrated management information system, the communication and control system, and the education and training system. First, the integrated management information system is developed to meet individual demand of the franchise and affiliates. It can help affiliates save the cost of developing and maintaining their own management information systems and take advantage of the integrated effect of information sharing. Next, the communication and control system can assist the routine operations between the franchise and its affiliates to be processed efficiently. As a result, it can also promote the utilization of resources of the franchise system. Third, the education and training system provides the necessary training to the employees of the franchise and affiliates. It can help the franchise system keep good quality of personnel. In addition to that, it can also assure that the requirement of consistent quality of operations in the franchise system is met.

From the dimension of marketing, the model provides two components for the franchise system: the integrated marketing and advertisement and the CRM system. The component of integrated marketing and advertisement plans and executes activities of marketing and advertising for the franchise system. It also support the marketing promotion of individual affiliate website. On the other hand, the CRM system is used to effectively understand and satisfy the demand of customers. It can help the franchise electronic store keep good relationships with customers and create new opportunities of selling.

### 4.2 Implementation strategies

Since the new model is an innovative idea to establish the franchise system for electronic stores, generic strategies for implementing EC models are not enough for the implementation of the new model. Innovative strategies should be adopted for the model to be successfully implemented. This study proposes implementation strategies of the model according to the unique characteristics of the franchise system. Since the appropriateness of subjects of the franchise electronic stores will have a significant effect on the success of the new model, first of all, the strategy of the selection of subjects shall be carefully developed. Current franchise physical stores, electronic malls, and the IT solution providers are appropriate subjects of the franchise of the new model. And a good strategy to establish a franchise for electronic stores is by an alliance of these three types of enterprises. As for the selection of affiliates, the strategy shall target at current electronic stores and small firms that are interested in the business of electronic store.

In addition to the strategy of selecting subjects, several strategies are important for the implementation of the new model. These strategies are illustrated below in terms of operations, technology, and marketing. From the dimension of operations, there are strategies of the mode of cooperation, the source of income, the physical distribution, and the payment. From the dimension of technology, there are two strategies: the development of website, and the technical support. From the dimension of marketing, three strategies should be taken into consideration. They are strategies of the participation of marketing, the marketing mix, and the brand.

### **4.3 The feasibility analysis and practical implications**

The practical feasibility of the new model was validated by the NGT group discussion, the case study, and the questionnaire survey. The results are analyzed here. First, in the NGT group discussion, the group agreed that the new model is practically feasible. Overall, they agreed that those proposed implementation strategies are important and appropriate. Particularly, they thought that current franchises of physical stores are more likely to be initiators of the franchise system of electronic stores than current electronic malls and IT solution providers, although they are appropriate initiators, too. In addition to that, the group also argued that a strong bond of the franchise with its affiliates may be a critical factor to the success of the franchise system, and the physical distribution is very important in the operations of the franchise system. Both factors should be valued while implementing the new model.

Second, four cases of electronic stores, which have the industry background of chain stores, IT firms, electronic malls, and bookstores respectively, were studied. We found that all of them have some problems with respect to the management, the technology, and the marketing. These problems with their solutions were taken into consideration in our proposed strategies. For instance, one of them had some technical problems because they lacked sufficient technical staff and another faced channel conflicts with its physical retailers. The former problem can be solved by the strategy of technical support, and the place strategy will deal with the latter problem. Managers of these stores were interviewed about the feasibility of the new model and implementation strategies, too. All of them felt that the model was feasible and the strategies were appropriate. Specifically, they thought that the most appropriate franchise of the new model was an alliance of three potential subjects of the franchise we proposed. This is a very good point because such an alliance will have all necessary capabilities to implement the model.

The results of questionnaire survey also validated the practical feasibility of the new model and its implementation strategies. We had thirty-two respondent companies (10.66%) from this survey. General speaking, almost all respondents confirmed the feasibility of the model and implementation strategies. Especially, respondents of potential affiliates have a higher average score of agreement on the feasibility than respondents of

potential franchises. This may be related to the fact that those potential affiliates need such model to help them enter the market of electronic stores or help them solve the difficulties they are encountering in their business now.

To implement the new model, the proposed strategies should be appropriately executed. These strategies are aimed to completely solve common problems of electronic stores in an integrated way within a franchise system of the new model, which is different from current EC models, such as electronic malls, electronic marketplace, and affiliate programs, that can solve only a specific part of those problems. The successful implementation of the new model is dependent on the effectiveness of eight components of the model and the appropriateness of implementation strategies, and the integration of the model and implementation strategies. Specifically, several issues are critical for the implementation of the model. First, sufficient capabilities of the franchise are very important to implement the new model successfully. Secondly, attracting appropriate affiliates to join the franchise system is crucial to the operation of the system since whether the franchise system reach the economic scale will have great impact on its profitability. Finally, the franchise system must specify how operational and management activities of the franchise electronic store should be proceeded and thus can assure that all affiliate stores operate effectively and provide consistent quality products and services to customers.

## **5. Conclusions**

It is not easy to operate an electronic store for an individual firm, especially the small enterprise that lack of the required expertise and resources for running the electronic business. This study proposes a new EC model to help enterprises run electronic stores. The new model applies the franchise system of chain store, a very successful modern business model, to the management of electronic stores to take advantage of the chain's competitive power by integrating individual affiliate sites. This model provides eight components for the franchise: the integrated portal website with the personalized technology, the technical support for affiliated websites, the operations system of the franchise electronic store, the integrated marketing and advertisement, the integrated management information system, the communication and control system, the education and training system, and the CRM system. Implementation strategies of the model, which are quite different from those generic strategies commonly used in implementing EC models, are also proposed. These innovative strategies are developed with respect to dimensions of operations, technology, and marketing, so that they can help the model be successfully implemented.

The proposed model is practically feasible and can be adopted to establish the franchise system of electronic stores. In addition, the results of this study can also be used as the basis for the future study on EC business models. There are some directions for further research.

Specifically, develop prototype systems for those eight components of the new model and examine the effectiveness of implementation strategies of the new model through experimental studies will be very important for the technical transfer of the model. This study is going to advance to the development of prototype systems, which can then be used to examine the effectiveness of those implementation strategies.

## Acknowledgement

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## References

- [1] Bacus, D. A., Bacus, M. S. and Human, S. E., Choosing a Franchise: How Base Fees and Royalties Relate to the Value of the Franchise, *Journal of Small Business Management*, 31(3), 1993, pp. 91-104.
- [2] Baron, S. and Schmidt, R., Operational Aspects of Retail Franchises, *International Journal of Retail & Distribution Management*, 19(2), 1991, pp.13-19.
- [3] Brown, J. R. and Dev, C. S., The Franchisor-Franchisee Relationship, *Cornell Hotel and Restaurant Administration Quarterly*, 38(6), Dec. 1997, pp.30-38.
- [4] Cheng, G. -C., The Planning and Implementation of the Electronic Mall, *Information and Computer*, December, 1997, pp. 43-45.
- [5] Chu, G. H., The Study on Business Types and Optimization Models of the Chain Industry, A Master Thesis of the Institute of Business Administration in Chung-Yuan University, 2000.
- [6] Deitel, H. M., Deitel, P. J. and Steinbuhler, K., *E-business and E-commerce for managers*, Upper Saddle River, N. J.: Prentice Hall, 2001.
- [7] Ho, W. -C., The Management and Implementation of Electronic Commerce, *Communications of the Chinese Society of Information Managers*, 43, 1998, pp. 33-38.
- [8] Huang, C. K. and Dai, K. Y., The Domestic Environment Factors for Banking Electronic Commerce—Case Studies, *Proceedings of the 4th International Conference on the Academy and Practice of Information Management*, 1998, pp. 179-186.
- [9] Justis, R. T. and Judd, R. J., *Franchising (revised)*, DAME Publications, 1998.
- [10] Kalakota, R. and Whinston, A. B., *Frontiers of Electronic Commerce*, Reading, Mass.: Addison-Wesley, Inc., 1996.
- [11] Lafontaine, F. and Kaufmann, P. J., The Evolution of Ownership Patterns in Franchise Systems, *Journal of Retailing*, 70(2), 1994, pp. 97-113.
- [12] Lee, H. M., *Chain stores*, Taipei: Shan-Chiou Cultures, 1995.
- [13] Lee, M. S., *Chain Store Management—A Practical Guide*, Taipei: Science and Technology Books, 1998.
- [14] Lin, C. Y., The Study on the Match of the IS Objectives and the Organizational Objectives, *Giao-Tung University Management Journal*, 18, 1998, pp.1-18.
- [15] Lin, G. -H. and Chuang, P. -Y., The Study on Adoption Decision Factors and Business Models of the Electronic Store, *Proceedings of the 10th International Conference on Information Management*, 1999, pp. 332-339.
- [16] Rappa, M., *Business Models on the Web*, <http://digitalenterprise.org/models/models.html>, 4/11/2002.
- [17] Sun, Y. -C., The Electronic Catalogue Survey and the Investigation of the Construction Models of Electronic Catalogue, A Master Thesis of the Institute of Business Administration in National Taiwan Science and Technology University, 1997.
- [18] Teo, S. H. and King, W. R., Assessing the Impact of Integrating Business Planning and IS Planning, *Information and Management*, 30, 1996, pp. 309-321.
- [19] Treese, G. W. and Stewart, L. C., *Designing Systems for Internet Commerce*, Reading, Mass.: Addison Wesley Longman, Inc., 1998.
- [20] Weill, Y. and Vitale, M., *Place to Space: Migrating to eBusiness Models*, Boston, Mass.: Harvard Business School Press, 2001.
- [21] Woll, M. Sources of Revenue to the Franchiser and Their Strategic Implications, *Journal of Retailing*, 44(4), 1968-1969, pp.14-20.
- [22] Yu, C. C., *Business Models and Case Studies of Electronic Commerce*, The Workshop on the Academy of Industrial Information Management and the Practice of Emerging Technologies, 2000.

# A Measurement Model of Trust in Internet Stores

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## Abstract

In this study we theoretically develop and empirically test a measurement model of consumer trust in Internet stores. In particular, we define the notion of trust based on what is commonly agreed on by scholars across disciplines. We treat trust as a second-order construct and measure it using four first-order components: perceived security, privacy, integrity, and transactional accuracy. We conducted controlled experiments using three Internet bookstores and 173 subjects. We applied confirmatory factor analysis to determine the measurement efficacies.

## 1. Introduction

There have been many discussions on what propels successful Internet commerce (IC). Based on value-focused thinking, Keeney [31] suggested that IC success might be more a function of customer's belief and perception of the net value of the benefits and costs of both a product and the processes of finding, ordering, and receiving it. The Federal Administration and the Better Business Bureau showed that consumer's trust is a critical factor in stimulating Internet purchase. Castelfranchi and Tan [8] showed that a lack of trust is one of the main reasons that consumers and companies do not engage in IC. Keen [30] argued that the most significant long-term barrier to Internet purchasing will be the lack of consumer trust, both in the company's honesty and in the company's competence to fill Internet orders. A recent survey by Information Technology Association of America also found that 62% of respondents believed that trust was the top overall obstruct.

Since trust is an important aspect of IC success, the understanding of its meaning and measurement is imperative. For academic research, this construct can be used as a dependent or independent variable in a nomological network that links IC with preceding and ensuring constructs. For management practice, metrics are a way of learning what works and what does not, what is reinforcing and what is disconfirming feedback [49]. Unfortunately, there is an alarming lack of effort in validating the instrument for trust. A few studies have examined the notion of trust [9, 21, 27, 33]. However, their definitions and instruments of trust are different. It makes it difficult to compare and accumulate findings and thereby to develop syntheses of what is known [14]. Javenpaa et al. [27] felt a need to reexamine

their instrument of trust adapted from marketing channels [17]. Lee and Turban [33] suggested that the construct should be reinvestigated in light of emerging technology, research and practice. They indicated that, if the construct is modeled incompletely and then integrated as part of a network of other constructs, the key aspects of variation among measures might be lost. The loss in explained variation can lead to errors in interpretation between dependent and independent variables within a system of path models [51]. The insufficiency of the metrics for IC trust corroborates with that of the metrics for information systems research in general and studies on net-enabled organizations in specific [53]. As Zmud and Boynton [58] noted, researchers have paid too little attention to measurement development issues and theoretical advancement has been constrained by the absence of reliable measures.

In this study we theoretically develop and empirically test a measurement model of consumer trust in Internet stores. In the parlance of latent variable statistics, we treat trust as a second-order construct and measure it using four first-order components: perceived security, perceived privacy, perceived integrity, and perceived transactional accuracy. The theoretical implication of higher-order models is that each first-order factor and the implied second-order factor are important in capturing the domain of the construct. Moreover, the second-order factor may be a more important mediator between a consequent and predictor variable than the first-order construct [51]. There is an additional consideration when choosing the current approach to the measurement of trust. Although it is prudent to borrow relevant scales from marketing to study IC, the unique feature of Internet technology warrants unique metrics for IC [52] and there is a danger associated with indiscriminate adoption [2]. In specific to the construct of trust in an Internet store, the unique feature of the Internet technology in terms of the conditions for trust to arise and the composition of trust [46] dictates that the notion of trust may be regarded as the synonym for security, privacy, or integrity; better cryptographic algorithms for data transmission and better authentication protocols for authenticity are considered equivalent to a higher level of trust. This consideration implies that trust in IC may be better reflected in multiple dimensions such as security, privacy, accuracy, and integrity.

## 2. A Theoretical Domain of Trust

To date, there is no universally accepted definition about what trust is. Economics define trust mainly as a phenomenon within and between institutions, and as the trust individuals put in those institutions [3]. Social psychology characterizes trust in terms of expectations and willingness of the trusting party in a transaction, the risks associated with acting on such expectations, and the contextual factors that either enhance or inhibit the development and maintenance of that trust [40]. Finance views trust as a level of subjective probability at which an agent will perform certain action [20].

Despite the differences in how trust is defined, scholars across disciplines seem to have two fundamental agreements. First, there is an agreement on what constitute trust: positive expectations of others [34] and willingness to be vulnerable [40]. Trust is a psychological state comprising the intention to accept vulnerability based on positive expectations of the behavior of another [46]. Second, why is someone willing to be vulnerable? There is an agreement on the necessary conditions for trust to arise: risk and interdependence. Risk is the perceived probability of loss [10, 35] and is an essential condition in psychological, sociological, and economic conceptualization of trust [16, 45, 57]. Trust would not be needed if actions could be undertaken without uncertainty and risk [35]. Uncertainty about what others intend to and will act appropriately is the source of risk [46]. Interdependence means the interests of one party cannot be achieved without reliance on another [46]. If one can achieve the interests without involving others, trust would not exist.

Table 1. Sample Trust Dimensions

Studies	Trust Dimensions
[4]	Information Security
[6]	Availability, Competence, Consistency, Discreetness, Fairness, Integrity, Loyalty, Openness, Promise Fulfillment, Receptivity
[15]	Ability, Trustworthy Intentions
[18]	Ability, Intention to delivery
[17]	Reputation, Size, Willingness to Customize
[22]	Ability, Intention, Trustee's Promises
[26]	Privacy, Security
[29]	Competence, Motives
[33]	Ability, Integrity, and Benevolence
[36]	Competence, Integrity
[44]	Moral, Integrity, Goodwill
[54]	Anonymity, Security, Transaction Size
[55]	Privacy

In the context of IC, both necessary conditions exist for consumers to trust Internet stores and online transactions. First, the perceived benefits of Internet shopping and/or established customer relations increase the interdependence between customers and online stores. IC is claimed to reduce prices, inventory levels, and the role of brokers [32]. It can reduce the advantages of scale of large retailers, lower the costs of entering international consumer markets,

reduce transaction cost, and are more convenient to make a purchase.

Second, Internet shopping involves more uncertainty and risks than traditional shopping. Internet consumers cannot physically check the quality and quantity of the products before receiving a purchase [35]. They cannot monitor the security of sending sensitive personal and financial information, like credit card numbers, through the Internet to a party whose behaviors and motives may be hard to predict [35]. Moreover, the free exchange of electronic information brings the threat of providing easy, and many times unwanted, access to personal information [51]. Consumers cannot control the use of their personal information after they release it to Internet stores during Internet shopping. In sum, the integrity of a store, the security of performing transactions, the accuracy of the transactions, and privacy are the four primary risk factors that cause trust issues to be a concern.

In addition to the analysis of the vulnerabilities that constitute trust, Churchill [14] suggested that extensive literature review and expert opinion provide a sound foundation on which a theoretical domain of trust can be found. Thus, we conducted an extensive review of the literature on trust. The review covered over 120 publications from academic journals, professional magazines, and textbooks, and identified over 40 repeating words that are characteristic of the trustworthiness of Internet stores. We also kept notes on various concerns and vulnerabilities that reflect each of these key words. We listed a sample of studies and their referenced attributes in Table 1. From the list we see that certain attributes like ability and competence are semantically identical or similar. Certain attributes like integrity, security, and privacy appear more frequently than others especially in the context of IC. Some attributes like consistency, atomicity, and discreetness reflect one fundamental concern about accuracy.

To verify the completeness of the list and consolidate conceptual redundancies, we formed a panel of "experts" and asked each member to add overlooked attributes, take away irrelevant ones, and identify similar or identical ones. The panel consisted of three professors respectively in the areas of MIS, Social Psychology, and Organization Studies, four Ph.D. students in Management and Information Systems, and 12 undergraduate students who had experience with Internet shopping. Through a session of brainstorming, we identified a shorter list of 9 items: security, privacy, integrity, accuracy, benevolence, fairness, motives, promise keeping, and capability. By definition, integrity is the perception that an Internet store is honest, ethical, and fair, and adheres to an acceptable set of principles [33]. Thus, integrity captures benevolence, fairness, motives, and promise keeping. Although many studies feel capability is an important dimension of trustworthiness, it is actually an enabler or formative (or causal) factor for other dimensions such as security, privacy, and accuracy. Therefore, the expert panel collectively judged that integrity along with

security, privacy, and accuracy covered the appropriate content domain of trust.

Based on the convergent views on the components of trust, we conceptualize trust as a psychological state comprising the intention to accept vulnerability when shopping in an Internet store. Then we conclude that such vulnerability is reflected in the four aspects: security, privacy, integrity, and accuracy.

**Perceived Security:** Web providers and users are now sharing the concerns on security that were once raised by environment control [26]. In the context of IC, communication can be intercepted, tampered, and falsified. Personal accounts can be accessed for illegal purposes. Personal properties can be damaged due to malicious attacks and viruses. Consequently, consumers are often unwilling to conduct online transactions for the fear of security breaches and potential damage to personal interests. As a matter of fact, the concern with security has become the top reason for not shopping online [26]. Therefore, to reflect the intention to accept the vulnerability in security, we conceptualize perceived security as the perception that making a transaction with an Internet store is safe. Such a notion of security signals the capability and responsibility of an Internet store in preventing unauthorized data access, illegal data interception, and illegal attacks on customer properties, and in protecting the interests of its customers. Of course, absolute security does not exist. We intend to operationalize the construct in terms of a comparison with traditional means of shopping and whether transmitted data could be intercepted, and accounts broken in.

**Perceived Privacy:** When associated with consumer activities that take place in the arena of electronic marketplace, the term privacy usually refers to personal information and the protection of its confidentiality. For example, when customers give out their identification numbers, they expect confidentiality that the numbers will only be known by the party who has a legitimate need to know them. Similarly, a customer who buys a bulk of marketing research data may not want his or her competitors to know it; a customer who buys a good of questionable value does not want to disclose his or her identity. The violation of privacy includes unauthorized collection, disclosure, or other misuse of personal information as a direct result of e-commerce transactions. Privacy has been identified as one of the most crucial issues in e-commerce. It is consumers' fear and distrust for potential loss of personal privacy that often makes them unwilling to conduct online transactions [55]. Therefore, to reflect their intention to accept the vulnerability in privacy, we conceptualize perceived privacy as the perception that their personal data with an Internet store are confidential. The concept signals the degree to which an Internet store is capable of and responsible for observing procedural fairness [26] and to exert control on its data collection, access, and secondary use [51]. It reflects a fundamental concern for the loss of proper control on personal data due to improper collection of private in-

formation, improper monitoring on Internet activities, and improper transfer of personal information.

**Perceived Integrity:** In physical commerce, customers often trust a business by its physical locations, facilities, and business licenses. However, they are not as much concerned with these characteristics per se as its integrity to conduct businesses honestly and professionally. The same concern becomes more serious when conducting online transactions. In e-commerce, it is virtually impossible to authenticate the identity of an Internet store through its physical characteristics. Thus, when making online transactions, customers deal with other parties whose true motives and absolute identity are uncertain [54]. Consequently, they are concerned about whether they will receive products or services even though they have paid for them. They are concerned about whether the store will take advantage of them and behave opportunistically. They are also concerned with whether the store has the capacity to offer products and services as it described. To reflect such concerns, we define perceived integrity to be the perception that an Internet store is honest and adheres to an acceptable set of principles [35]. As per the definition, integrity consists of two related aspects of semantics. First, it means that an Internet store does as what it said, i.e., it keeps promises and is procedurally fair. Second, it means that the store says as what it did, i.e., it is honest and credible. In prior studies, the term "reputation" is sometimes considered to be equivalent to perceived integrity. For example, Doney and Cannon [17] defined reputation as the extent to which customers in the industry believe that a company is honest and concerned about its customers. Based on such equivalence, perceived integrity signals the forbearance from opportunism [50] and reflects the capability and responsibility of a store to act professionally.

**Perceived Accuracy:** In Internet shopping, customers cannot physically touch, check or test a product. All they know about the product is from the descriptions or pictures provided by an Internet store. Besides opportunistic behaviors, customers are also concerned with potential transaction errors such as incorrect product brands, sizes, and quantities, as well as incorrect billing statements. Such errors can occur due to human mistakes. They can also occur due to computer system irregularities such as lack of transaction atomicity [54]. For example, when purchasing a document online, a power failure between sending in payment and obtaining a password to download the document can leave the transaction partially finished. Ideally, such a transaction should be rolled back so that the customer can re-start the process again. However, without atomicity control, the customer will end up with troubles and delays or paying for another transaction. In physical commerce, such errors can be easily corrected using a trip or phone call back to the store. However, making corrections with an online store typically means extra effort and time and sometimes even extra shipping and handling fees. Therefore, Javenpaa et al. [27] suggested that, in order to be able

to trust an Internet store, a customer must believe that the store has both the ability and the motivation to reliably deliver goods and services of the quality expected. Similarly, Butler [6] suggested the dimension of transaction accuracy by emphasizing the criteria such as consistency and discreetness. To capture such a dimension of trust, we conceptualize perceived accuracy as the extent to which a customer believes that transactions with an Internet store are error-free. This concept signals the capability and responsibility of an Internet store in performing its functions accurately.

### 3. Data Collection

Following the advice by Churchill [14], we utilized the expert panel and a class of undergraduate students to participate in a pre-test and a pilot test respectively. In the pretest, we provided a formal definition of each construct and then a list of measurement items (sentences), which we intend to use to measure the constructs. We asked each member to first read each definition carefully and then give a rating for each item in the 5-point scale to indicate how well the sentence matches the intended construct.

The pretest started with 48 items in total. After the pretest, we analyzed the ratings of each item individually. An item was retained if it was consistently scored 4 or 5 points across the experts. It is dropped if it was consistently rated as no match. For an item that had inconsistent ratings, we adopted alternatives, rephrased it, or dropped it entirely. The pretest substantially refined some of the items by eliminating their ambiguity. The number of items was also reduced to 33.

To further validate the items, we conducted a pilot test using 35 undergraduate students. We randomized the 33 items and created a survey that asked each participant to visit amazon.com and respond to each item by indicating how much he or she agreed with its statement. Then we used the responses and calculated the correlation between each pair of the items. Under each dimensional construct, we retained those items that were highly correlated. However, if an item seemed not to go along with others, we dropped or modified it depending on its content. Through the pilot test, we finally selected 17 items in total for the final test (see Table 2).

The final test involved 173 participants selected from graduate and undergraduate students in two large national universities. Nevertheless, if a subject is not aware of Internet technology and its potential problems, he or she may not make perfect sense of some of the statements in Table 2. Therefore, when identifying participants, we required them to have exposure to electronic commerce. To be representative of the population actually engaging in IC activities, we identified the subjects from students at various stages: 24% from graduate programs, 38% from juniors and seniors, and 38% from freshmen and sophomores. We also distributed the subjects roughly equally in two regions,

Midwest and Northeast, in the hope to capture the variation due to urban and rural settings. The subjects were primarily selected from 4 graduate and 8 undergraduate classes on the voluntary basis. Among the individuals who were qualified to participate, the response rate was 73%.

Table 2. Initial Measurement Items for Trust

<b>Perceived Security</b> (5-point Scale Anchored by "Strongly Disagree" and "Strongly Agree")	
PS1	I believe that shopping on this Internet store is just as safe as placing an order by phone
PS2	It is just as safe to make a credit card purchase at this Internet store as it is to make one in person
PS3	The data transmission between my computer and this Internet store is safe
PS4	This Internet store is capable of preventing illegal access
<b>Perceived Privacy</b>	
PP1	I trust that this Internet store will keep customer information confidential
PP2	I am afraid that this internet store might misuse my personal information (Reverse)
PP3	I think it's likely that this store would sell my personal data to others (Reverse)
PP4	This store can be trusted to keep the identities of its customers private
<b>Perceived Integrity</b>	
PI1	I have confidence in this store
PI2	I trust this store to keep my best interests in mind
PI3	I trust this store to act professionally
PI4	Something about this store strikes me as deceptive and misleading (Reverse)
<b>Perceived Accuracy</b>	
PA1	I would trust this store to deliver exactly what I order
PA2	The Internet store can be trusted to fulfill my order accurately
PA3	The store will not overcharge my credit/debit account
PA4	The online product and service information is accurate
PA5	This store will make corrections if my order is in error

In order to ensure the representativeness of our sample to the Internet user population, we collected general and technology demographic data using Gvu's WWW User Survey instrument. The participants had ages ranged from 20 to 46 and were on the average 24 years old. 92% of them were English speakers and other 8% spoke Spanish, Chinese, French, etc. More than 90% of the subjects had 2 to 17 years work experience. All except for a few subjects used Internet and web browsers once or several times a day. 72% had purchased goods and services on the Internet and 40% made a purchase for more than 100 dollars. 46% shopped on the Internet frequently. Most of these demographics match the corresponding sample statistics of thousands of Internet users recently surveyed by Georgia Institute of Technology.

Consistent with prior work [27], we used online bookstores to conduct the controlled experiment and to collect data. To avoid possible biases due to the familiarity [21] with a particular store, we searched all online bookstores and identified three at potentially various levels of familiarity to the subjects. We randomly assigned the subjects to the three stores with approximately equal number of subjects assigned to each. Among those assigned to the first

store, all had heard about it and more than half had visited it before. Among those assigned to the second store, 69% had heard about it and 19% had visited it. Among those assigned to the third store, only one had heard about it but none had visited it.

After the participant-store assignment, we provided each subject with a cover page that guides him or her to visit the store, search for a textbook to buy, create an account with the store, and proceed to finish the order. We also provided a credit card number, a billing address, and a social security number for them to create accounts and check out the books. The goal of the experiment was to simulate real Internet shopping experience. After the experiment, each subject was asked to respond to a survey regarding their attitudes to Internet shopping, their perceptions about the store, and their willingness to purchase from the store. For each question, we used a 5-point Likert scale anchored by “Strongly Disagree” and “Strongly Agree.” And we gave sufficient time for them to finish the survey.

#### 4. Hypothesized Models of Trust

According to the analysis of the content domain of trust, we see that a common theme of the dimensional constructs is the ability and responsibility of an Internet store. Ability and responsibility form the basis of trust and a lack of either characteristic will lead to no trust. One would not trust an Internet store if it were not capable even though it has good motives. Similarly, he or she would not trust it either if it were not responsible even though it may be capable. On the other hand, if a store is both capable and responsible, what else does one need to be able to trust it? There is possibly none. Therefore, we considered the trustworthiness to be the overall sum of perceived ability and responsibility. Many other authors also suggested the two overall and possibly uncorrelated dimensions of trust. [15, 18] proposed ability and trustworthy intentions as the two overall dimensions of trust. Kee and Knox [29] proposed competence and motives.

Then why do not we measure trust using the two larger dimensions: perceived ability and perceived responsibility? The reason is that they are formative rather than reflective factors of trust. In general, to measure trust using first-order factors, trust must be a common factor underlying the first-order factors rather than be a simple sum of them. The fundamental issue is consistency in directional change among the first-order constructs [11]. In particular, does a directional change in ability imply similar directional shift in responsibility? The answer is possibly negative; an organization is capable does not necessarily imply it is responsible.

On the other hand, ability and responsibility as a common core of trust underlie perceived security, perceived privacy, perceived integrity, and perceived accuracy. If a store is capable of and responsible for its business, it will act professionally to improve its perceived in-

tegrity. It will also take a strong measure to ensure security, customer privacy, and transaction accuracy. Therefore, perception in any of the four dimensions is manifested in perceptions in the other dimensions through a larger perception of ability and responsibility. For example, if a customer found that his account had been hacked and modified, he would naturally doubt the ability and/or responsibility of the store and infer that his privacy and expectation of accuracy would be in danger. His perception of its professionalism would be also reduced.

In sum, trust in an Internet store is reflected in the four specific dimensions such as perceived security, perceived privacy, perceived integrity, and perceived accuracy. The overall trustworthiness accounts for the interrelationships among these dimensional factors through the perception of the ability and responsibility of the store. Based on this hypothesis, let us propose and examine six measurement models that are plausible representation of our anticipation.

##### *First-Order Factor Models*

Model 1 hypothesizes that one first-order factor — trust in Internet stores — accounts for all the common variance among the 17 items. As we reviewed before, most existing studies have approached trust in Internet stores as a single-dimensional construct [13, 21, 27]. Typical survey questions to assess trust include “This store is trustworthy” [27] and “I trust this store” [21]. If this model is accepted, then it is appropriate to view trust as a single dimensional construct.

Model 2 hypothesizes that two first-order factors account for the variance of 17 items. In this model, perceived privacy and perceived security are combined into one factor, and perceived integrity and perceived accuracy into another. This model emphasizes perceptions in two primary areas: data and goods. The first combination is due to data and is plausible because both security and privacy have a common underpinning: personal information. If data are not secured in transmission and storage, privacy cannot be enforced even though a store does not violate it voluntarily. The second combination reflects that a customer is concerned with whether she will receive goods as expected and be charged correctly regardless whether a discrepancy is due to a mistake or due to a lack of integrity.

Model 3 hypothesizes that 17 items form two first-order factors. However, it combines perceived integrity and perceived privacy into one construct and perceived security and perceived accuracy into another. This model focuses on two overall dimensions: capability and motives. Integrity and privacy are more reflective of the motives of a store whereas security and accuracy are more reflective of its capabilities.

Model 4 hypothesizes still another two first-order factor structure, where perceived integrity is distinct whereas other three are combined into one first-order construct. The justification for this model is as follows. Perceived security, perceived privacy, and perceived accuracy are all

perceptions from the perspective of consumers' own interests such as their security, their privacy, and their orders. On the other hand, perceived integrity is more a perception of the characteristics of an Internet store.

Model 5 hypothesizes that four first-order factors account for the variance of all items. Prior theoretical analysis of content domain provides support for this model. Essentially, this model assumes that every pair of constructs correlate but the correlation is not strong enough to justify for a merger. In addition, this model will act as a benchmark for the test of a second-order model. According to Marsh and Hocevar [39], although a higher-order model is able to explain the covariance of first-order factors, the goodness-of-fit of the higher-order model can never be better than that of the corresponding first-order model. Thus, this model provides a target for testing a second-order model.

#### *A Second-Order Factor Model*

Model 6 hypothesizes that four first-order factors account for the variance of the 17 items whereas a second-order factor accounts for the covariance of these first-order factors. Statistically, if Model 5 demonstrates significant interdependence (covariation) among the first-order factors, a natural inference is that there might be a common factor that accounts for the interdependence [42]. If such a common factor exists, then trust will be more than the sum of the four first-order factors. It will consist of the first-order factors as well as the structure of interrelationships among them [51].

Theoretically, ability and responsibility form a common core of trust that underlies the four first-order factors. As we have argued, each first-order construct reflects the ability and responsibility of an Internet store in a specific dimension such as security, privacy, integrity, or accuracy. Therefore, the perceived ability and responsibility, i.e., the trustworthiness of the store, not only extract the variation of these first-order factors but also account for the interrelationships among the first-order factors. Thus, trust in an Internet store may be better measured as the second-order common factor.

## **5. Data Analysis**

To validate the hypothesized models, we employed confirmatory factor analysis using LISREL 8.3 [28]. In the current study, the observed covariance matrix for the 17 measurement items is listed in Appendix. The latent variables include the four first-order factors and one second-order factor. Different measurement models hypothesized in Section 5 underlie different joint distributions of all the variables involved, observed and latent as well. How much each model fits the data can be determined by the extent to which its implied covariance matrix matches the observed one.

As its rationale implies, an important assumption of confirmatory factor analysis is multivariate normality. However, a verification of this assumption is difficult. In-

stead, we conduct normality test for each observed variable using both normal plots and Kolmogorov-Smirnov statistic. All normal plots show straight lines and all test statistics are strongly significant at  $\alpha = 0.000$ . They indicate no departure from univariate normality. The test result signals that the multivariate normality holds.

Before conducting confirmatory test on the hypothesized models, we followed the procedure suggested by Segars [47] and tested each first-order factor in isolation first and then in pairs. The procedure can provide the fullest evidence of measurement efficacy and reduce the likelihood of confounds in full structural equation modeling [48]. In the initial phase of isolated model testing, we found that items PA4, PA5, and PS4 have loadings less than 0.6. By analyzing the correlation matrix, we realized that these items seem not to go along with other items under the same construct. Therefore, we deleted these three items to improve the reliability of corresponding constructs. All items under perceived integrity and perceived privacy had reasonably large loadings. However, the modification indices for the test of perceived privacy suggest adding an error covariance between PP2 and PP3. Being reluctant to delete additional items, we add other first-order constructs and conducted paired tests. All test results seem fine except that a similar modification index suggests the existence of error covariance between PP2 and PP3. By analyzing these items, we can see that they both are reversed and both suggest misuse of personal information. Thus, to remove the extraneous correlation that is not captured by the notion of perceived privacy, we deleted PP3. After removing PA4, PA5, PS4, and PP3, all isolated and paired tests went through well.

Finally, we used the remaining 13 items to test the six hypothesized models. Table 3 provides a summary of the model-fit indices and their thresholds recommended by previous studies. As shown, by all measures of fit Models 5 (four first-order factors) and 6 (the second-order factor model) are deemed excellent while alternative models being deemed unacceptable. Models 5 and 6 both had insignificant  $\chi^2$  statistics with p-values above 0.4, which is far higher than the threshold 0.05. They satisfied other cited criteria in terms of GFI, NFI, RMR, RMSEA, and the ratio of  $\chi^2$  to degree of freedom, as well as the more stringent criterion of AGFI [12, 23]. Most strikingly, their corresponding probabilities of close fit, i.e.,  $RMSEA < 0.05$ , are all higher than 0.95. It means that the type I error of rejecting a not-close fit hypothesis is less than 0.05 [5].

It is interesting to observe from Table 3 that, while all often-cited fit indices being able to tell a good model fit from a bad one, their powers of detection are not equal. According to the ratio of  $\chi^2$  to degree of freedom, Models 2 and 3 might be declared acceptable because their ratios are close to 2. Similarly, the NFI, GFI, and AGFI for Models 1-4 are all close to 0.8 and some values are even close to 0.9. The corresponding values of RMR are close to or less than 0.08. Using less stringent criteria, these models would

be judged acceptable. However, by using the  $\chi^2$  statistic and  $P(RMSEA < 0.05)$ , these models fall apart and a clear distinction from Models 5 and 6 can be identified.

Table 3: Measures of Model Fit: Alternative Models

Model	1	2	3	4	5	6	
$\chi^2$	228.61	142.19	146.20	196.40	57.24	63.13	
df	65	64	64	64	59	61	
$\chi^2/df$	3.517	2.222	2.284	3.069	0.970	1.035	<2.00
$\chi^2$ Sig.	0.000*	0.000*	0.000*	0.000*	0.541	0.401	>0.05
NFI	0.785	0.825	0.819	0.818	0.935	0.927	>0.90
CFI	0.841	0.896	0.890	0.876	0.998	0.992	
GFI	0.830	0.887	0.884	0.851	0.951	0.947	>0.90
AGFI	0.762	0.840	0.836	0.788	0.925	0.920	>0.90
NNFI	0.809	0.874	0.866	0.849	0.997	0.990	
RMR	0.080	0.068	0.075	0.074	0.041	0.046	<0.05
RMSEA	0.121	0.084	0.086	0.110	0.000	0.014	<0.05
$P(<.05)$	0.000	0.002	0.001	0.000	0.977	0.956	>0.90

Table 4. The Indices of Convergent Validity

	PS	PP	PI	PA
Composite Reliability	0.79	0.76	0.83	0.71
Cronbach a	0.76	0.80	0.83	0.71
AVE by Regressions	0.56	0.51	0.55	0.45
TVE by Principal Factor	0.68	0.72	0.66	0.63

Table 5. Results of Discriminant Validity Tests

Test	Original $\chi^2$	Alternative $\chi^2$	$\chi^2$ Difference
<b>PI</b>			
PA	10.56 (13)	42.28 (14)	31.72***
PS	9.59 (13)	74.06 (14)	64.47***
PP	11.70 (13)	81.45 (14)	69.75***
<b>PA</b>			
PS	14.10 (8)	54.23 (9)	40.13***
PP	5.31 (8)	72.03 (9)	66.72***
<b>PS</b>			
PP	6.49 (8)	76.05 (9)	69.56***

### Convergent Validity

Figure 1 illustrates the structure and estimated parameters of the four-construct, first-order factor model (Model 5). As shown, the indicator loadings of items to their respective constructs are all above 0.60, indicating that each measure is accounting for 50 percent or more of the variance of the underlying latent variable [11]. The t-values obtained for the coefficients range from 8.317 to 13.564, indicating that all factor loadings are significant at the level  $\alpha = 0.0001$ . The significance level is far in excess of the critical value 0.01 suggested by Hair et al. [23]. Both loadings and their significance levels provide strong evidence to support the convergent validity of the items [1].

The composite reliability indices of [19] are listed in Table 4. As shown, they are all in excess of 0.70, implying acceptable level of reliability for each of the constructs [28]. As a comparison, we also show the corresponding Cronbach  $\alpha$  coefficients, which are also higher than the accept-

able threshold 0.7 [41]. As a similar indicator of measurement reliability, average variance extracted (AVE) represents how much variance in each item on the average is explained by the corresponding construct [19]. It is conceptually similar to the total variance extracted (TVE) in principal factor analysis. The AVE values based on the formula of [19] are listed in Table 4. As shown, except for perceived accuracy, the AVE for each construct is above 0.5. It indicates that, on the per-item average basis, the amount of variance captured by the first-order construct is more than the amount of variance due to measurement error. The AVE of perceived accuracy is 0.45, which is a little bit lower than 0.50 (see Section 7 for a discussion). As a comparison, we computed the TVE value for each construct by using the eigenvalues of the correlation matrix of its scale items. As shown, all TVE values are higher than 0.6, indicating that more than 60% of total variance contained in all the items is captured by the corresponding factor. In sum, all indices suggest the first-order constructs exhibit strong properties of convergent validity.

### Discriminant Validity

Discriminant validity is the extent to which items measuring two distinct constructs are shown to be empirically distinct and not so highly related to each other [7]. To do the test, we made a series of comparisons between the original model, where two constructs are treated as distinct, and the alternative model, where they are united as one construct. Discriminant validity is implied if the  $\chi^2$  statistic of the original model is significantly lower than that for the alternative model; this suggests that the original model has a better model fit.

Table 5 shows the results in all six paired comparisons. All the  $\chi^2$  differences are highly significant at  $p < 0.001$ . Hence, each item seems to capture a construct that is significantly unique from other constructs, providing strong evidence of discriminant validity. Also importantly, the estimated correlation between each pair of constructs is below the suggested cutoff value 0.90 [19], indicating distinctness in construct content.

### Testing the Second-Order Model

Both convergent and discriminant validities indicate how well the first-order constructs are defined and measured. However, our eventual goal is to determine how well trust as a higher-order construct captures the variance and covariance of these first-order constructs. To formally test the validity of the second-order factor model (Model 6), we need to first compare its model fit with that of the baseline model (Model 5). Compared to the baseline model, the second-order factor model explains the covariance among first-order factors in a more parsimonious way. Thus, even when the higher-order model is able to explain the factor covariance, its goodness-of-fit can never be better than the corresponding first-order model. In this sense, the first-order model provides an optimum fit or target for the higher-order model [39]. It has been suggested that the

efficacy of a second-order model be assessed using the so-called target coefficient, i.e., the ratio of  $\chi^2$  (baseline model) to  $\chi^2$  (second-order model). This coefficient has an upper bound of 1.0 with higher values indicating the higher power of the second-order factor in capturing the covariance among first-order factors. Figure 2 shows the structure and estimated parameters of the second-order factor model of trust (Model 6). The overall  $\chi^2$  is 63.13 that is insignificant with a p-value = 0.40 (see Table 3). Adjusting the degree of freedom, the normed value of  $\chi^2$  is 1.04, indicating an excellent model fit and no evidence of over-fitting. The target coefficient is a very high value 0.91, indicating that the introduction of the second-order factor into the baseline model does not significantly increase  $\chi^2$ . Since the second-order model is more parsimonious, it should be accepted as a better representation of the “true” factor structure according to Occam’s razor [42].

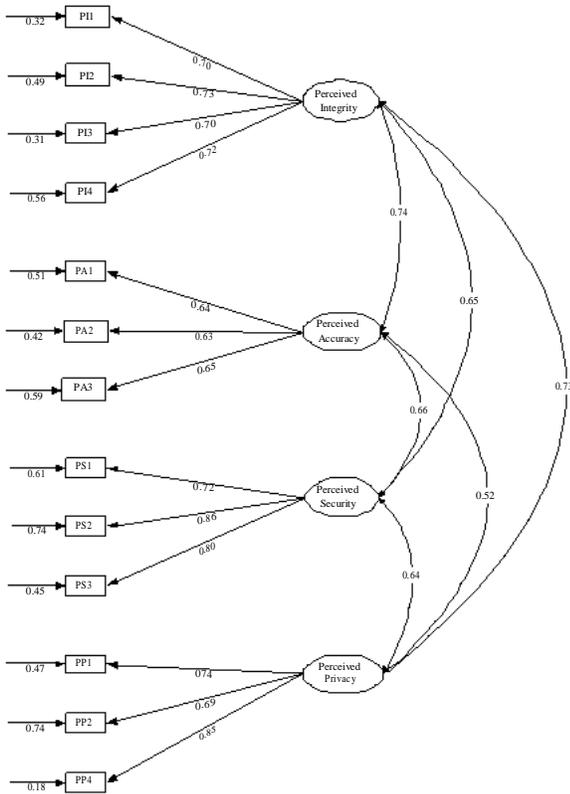


Figure 1. A First-Order Model of Trust

In addition to target coefficient, the power of the second-order factor in explaining the variance of the first-order factors provides another piece of evidence in support of the second-order factor structure. The path loadings to perceived security, perceived privacy, perceived integrity, and perceived accuracy are respectively 0.77, 0.78, 0.92, and 0.78 with t-values ranging from 7.03 to 9.9. The corresponding  $R^2$  values are respectively 0.59, 0.61, 0.85, and 0.61. Similar to the loadings from a first-order factor to its observed items, these loadings and their significance show

a strong convergent validity and reliability of the second-order factor [11]. To obtain overall validity indices, we can similarly compute the composite reliability and AVE of the second-order construct, which are respectively 0.89 and 0.66. Segars and Grover [48] noted that the most convincing evidence of the explanation power is the observed total coefficient of determination. This statistic is 0.94 for Model 6, indicating that a large amount of variance and covariance among the four first-order constructs is explained by the second-order factor and captured by the regression models.

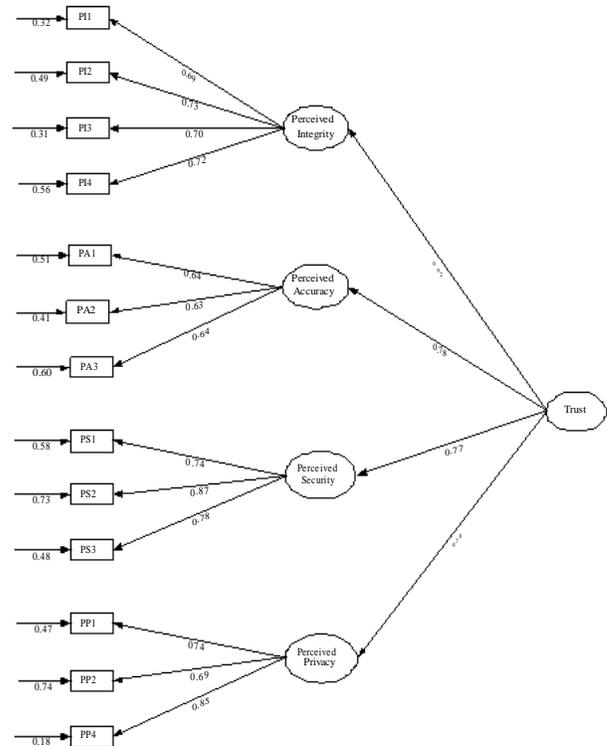


Figure 2. A Second-Order Factor Model of Trust

All evidence in support of the second-order model has been based on type I errors. Then, is it likely that we accept a wrong hypothesis of close fit but in fact the model has a bad or mediocre fit? To answer this question, we conducted power analysis for tests of fit using the technique proposed in [27, 37] and considered  $RMSEA < 0.08$  to be a good fit. Browne and Cudeck [5] suggested a more restrictive criterion:  $RMSEA < 0.05$  for close fit and  $RMSEA$  between 0.08 and 0.1 for mediocre fit. Based on the latter stringent criterion, we used the SAS program provided by MacCallum et al. [37] and computed the power indices with various  $RMSEA$  values in [0.08, 0.1] representing mediocre fit. We found that Model 6 has a power between 0.77 and 0.99, implying that more than 77% of time we can reject a hypothesis of close-fit if the model indeed has a mediocre fit. By using a more lenient criterion, such a power can increase to almost 100%. Therefore, based on Type II errors, the second-order model will be still considered to fit data well.

## 6. Conclusions and Discussions

From the perspective of potential risks and vulnerabilities involved in online shopping, we conceptualized the first-order constructs of perceived security, perceived privacy, perceived integrity, and perceived accuracy, and proposed measuring trust in an Internet store using these dimensions. Then, by conducting an extensive review of literature on trust, a pre-test, and a pilot test, we operationally defined the first-order constructs and developed scale items to measure them. We conducted a controlled experiment that provided a simulated online shopping experience to all participants before they responded to our survey.

To be consistent with a wide range of existing studies on trust, we believed ability and responsibility to be an overall dimension that governs how the trustworthiness of an Internet store is perceived. Therefore, we hypothesized the equation that trust = perceived ability + perceived responsibility. Then, based on this equation, we theoretically justified that the first-order factors—perceived security, perceived privacy, perceived integrity, and perceived accuracy—are the reflections of a single higher-order construct, trust. Each first-order factor is manifested in other first-order factors through trust. In addition to this second-order factor model, we proposed 5 alternative first-order factor models, with a four-factor model as the target for benchmarking the test of the second-order model.

We employed confirmatory factor analysis using LISREL. We used selected items and tested the six hypothesized models. We reported all model fit indices cited in the existing information systems research and additional ones such as the significance of  $\chi^2$  and the p-value for RMSEA < 0.05, which we felt are powerful in separating a good model from mediocre ones. All the indices and their corresponding criteria clearly indicate the superiority of the second-order factor model and the four first-order factor model while rejecting the acceptance of other alternative models. By using the statistics of the first-order model, we determined that the four first-order factors are empirically valid in terms of their convergent and discriminant validities. Finally, we determined that the second-order model is a better representation of the factor structure than the first-order counterpart based on its parsimony, the target coefficient, and the total coefficient of determination. We also empirically determined the power of such a test of the second-order model to be close or higher than 0.8.

Before we discuss the implications of this study, its limitations should be noted. First, the use of student subjects and Internet bookstores may limit the generalizability of the results. Although we carefully simulated and controlled many parameters so that our sample is representative of the Internet user population, a further replication using real online customers might be worthwhile. The second limitation is about the use of confirmatory factor analysis. As we noted, the technique essentially validates a joint distribution assumption using the conformance of its

marginal to observed data. There is a possibility that there exist equivalent models [24]. In this study, we build our models based on a conceptual foundation. We also explored alternative models. The chance of having equivalent models is slim. Third, our measurement model has an excellent model fit. In comparison, the reliability of perceived accuracy is a bit low. Its AVE is 0.45, which is below the recommended value 0.5 [19]. The problem is largely due to the early stage of research in the area. We found a similar problem in some existing studies.

All statistical evidence converges and is in support of our conceptualization that trust is a multi-dimensional construct and is well measured by perceived security, perceived privacy, perceived integrity, and perceived accuracy. We also found that the notion of trust, as a second-order construct, accounted for most of variance and covariance in the first-order factors. These results have several implications. First, they imply that trust is more complicated than previously thought. In general, consumers manifest their trust in an Internet store through their perceptions in security, privacy, integrity, and accuracy. In other words, customers reflect their trust in an Internet store through their perceptions that their shopping activities are safe, their privacy is protected, their transactions are error-free, and the store acts professionally. Furthermore, the results indicate that consumers have vulnerability concerns in all these aspects rather than in any particular dimension and that the interrelationships among these factors are an important component of accurately measuring trust. Second, the results imply that the measurement of trust in an Internet store, although complicated, can be done through an indirect measurement of the first-order factors. Such a measurement model will provide an important metric of the effectiveness of an Internet store for its managers and/or an important metric of vulnerability, perceived risk, as well as expectations of consumers when shopping online. Third, since each first-order construct is manifested in the others through perceived ability and responsibility, our results imply that a store can manipulate certain variables in order to improve consumer trust. For example, by providing accurate billing statements or filling customer orders accurately, a store can convey a sense of ability and responsibility. Such a sense will improve the customer perception in security and integrity that will otherwise be difficult to achieve.

## References

- [1] Anderson, J.C., & Gerbing, S.W. 1988. Structural equation modeling in practice: A review and recommended two-step approach. *Psychological Bulletin* 103(3) 411-423.
- [2] Benbasat, I. 1991. Commentary. K. L. Kraemer, ed. *The Information Systems Research Challenge: Survey Research Methods* vol. 3. Harvard Business School, Boston, MA.
- [3] Bhattacharya R., Devinney T. M., & Pillut la M. M. 1998. A formal model of trust based on outcomes. *Academy of Management Review* 23(3) 459-472.
- [4] Brewer D. 1999. Keeping virtual worlds open for business. *Telecommunications* 33 65-66.

- [5] Browne, M. W. & Cudeck, R. 1993. Alternative ways of assessing model fit. In Bollen, K. A. & Long, J. S. (Eds.). *Testing structure equation models*. Newbury Park, CA. Sage. 136-162.
- [6] Butler, J. K. Jr. 1991. Toward understanding and measuring conditions of trust: evolution of conditions of trust inventory. *Journal of Management* 17(3) 643-663.
- [7] Campbell, D. T. & Fisk D. W. 1959. Convergent and discriminant validation by the multitrait – multimethod matrix. *Psychological Bulletin* 16 81-105.
- [8] Castelfranchi, C., & Tan, Y. H. (eds.) 2002. *Trust and deception in virtual societies*. Dordrecht, Netherlands: Kluwer Academic Publishers, forthcoming.
- [9] Cheung, C. & Lee, M. K.O. 2001. Trust in Internet shopping: Instrument development and validation through classical and modern approaches. *Journal of Global Information Management* 9,23-35.
- [10] Chiles, T. H., & McMackin, J. F. 1996. Integrity variable risk preference, trust, and transaction cost economics. *Academy of Management Review* 21 73-99.
- [11] Chin, W.W., 1998. Issues and opinions on structural equation modeling. *MIS Quarterly*.
- [12] Chin, W.W. and Todd, P.A. 1995. On the use usefulness, and ease of use of structural equation modeling in MIS research: A note of caution. *MIS Quarterly*. 19(2) 237-245.
- [13] Chircu, A. M., Davis, G.B. & Kauffman, K. J. 2000. The role of trust and expertise in the adoption of electronic commerce intermediaries. *Working paper*.
- [14] Churchill, G. A. 1979. A paradigm for developing better measures of marketing constructs. *J. of Marketing Research* 16 64-73.
- [15] Cook, J. & Wall, T. 1980. New work attitude measures of trust, organizational commitment, and personal need nonfulfillment. *Journal of Occupational Psychology* 39-52.
- [16] Coleman, J. S., 1990. *Foundations of Social Theory*. Cambridge, MA: Belknap Press.
- [17] Doney, P. M., & Cannon, J. P. 1997. An examination of the nature of trust in buyer-seller relationships. *Journal of Marketing* 61(2) 35-51.
- [18] Deutsch, M. 1960. The effect of motivational orientation upon trust and suspicion. *Human Relations* 13 123-140.
- [19] Fornell, C. & Larcker, D. F. 1981. Evaluating structural equation models with unobserved variables and measurement error. *Journal of Marketing Research* 39-50.
- [20] Gambetta, D. 1990. Can we trust Trust?, In *Trust: Making and Breaking Cooperative Relations*, Gambetta, D. (ed.), Basil Blackwell, Oxford 213-237.
- [21] Gefen, D. 2000. E-commerce: The role of familiarity and trust. *Working paper*.
- [22] Good, D. 1988. Individuals, interpersonal relations, and trust. In Gambetta, D. G. (ed.). *Trust: Making and breaking cooperative relations*. Oxford: Basil Blackwell. 31-48.
- [23] Hair, J. F. Jr., Anderson, R. E., Tatham, R. L. & Black, W. C. 1998. *Multivariate Data Analysis with Readings*, 5th Edition. Englewood Cliffs, NJ: Prentice Hall.
- [24] Hayduck, L. A. 1996. *LISREL Issues, Databases, and Strategies*. The Johns Hopkins University Press, Baltimore and London.
- [25] Hinkin, T. R. 1998. A brief tutorial on the development of measures for use in survey questionnaires. *Organizational research methods* 16(1) 104-121.
- [26] Hoffman, D. L., Novak, T. P. & Peralta M. 1999. Building consumer trust online. *Communications of the ACM* 42(4) 80-85.
- [27] Javenpaa, S. L., Tractinsky N., & Vitale M. 2000. Consumer trust in an Internet store. *Information Technology and Management* 45-71.
- [28] Jöreskog, K.G., & Sörbom, D. 1989. *LISREL 7 user's reference guide*. *Scientific software*, Chicago, IL.
- [29] Kee, H. W. & Knox, R. E. 1970. Conceptual and methodological considerations in the study of trust. *J. of Conflict Resolution*. 14 357-366.
- [30] Keen, P. G. W. 1997. Are you ready for "trust" economy. *ComputerWorld* 31(16) 80.
- [31] Keeney, R. L. 1999. The value of Internet commerce to the customer. *Management Science* 45(4) 533-542.
- [32] Lee, H. G. 1998. Do electronic marketplaces lower the price of goods. *Communications of the ACM* 73-80.
- [33] Lee, M. K. O. & Turban, E. 2001. A trust model for consumer Internet shopping. *International Journal of Electronic Commerce* 6(1) 75-91.
- [34] Lewicki, R. J. & McAllister, D. J. 1998. Trust and distrust: measuring the difference. *Unpublished Manuscript*, Ohio State University.
- [35] Lewis, J. D. & Weigert, A. 1985. Trust as a social reality. *Social Forces* 63 967-985.
- [36] Lieberman, J. K. 1981. *The Litigious Society*. New York: basic Books.
- [37] MacCallum, R. C., Browne, W. & Sagawara, H. M. 1996. Power analysis and determination of sample size for covariance structure modeling. *Psychology Method* 130-149.
- [38] MacCrimmon, K. R. & Wehrung, D. A. 1986. *Taking Risks: the Management of Uncertainty*. New York: Free Press.
- [39] Marsh, H. W. & Hocevar, D., 1985. Application of confirmatory factor analysis to the study of self-concept: First and higher order factor models and their invariance across groups. *Psychological Bulletin* 97(3) 562-582.
- [40] Mayer, R. C., Davis, J. H. & Schoorman, D. 1995. An integrative model of organizational trust. *Academy of Management Review* 20 709-734.
- [41] Nunnally, J. C. 1967. *Psychometric Theory*. New York: McGraw-Hill.
- [42] Pearl, J. 2000. *Causality: Models, Reasoning, and Inference*. Cambridge University Press, Cambridge, UK.
- [43] Peter, J. P. 1981. Construct validity: review of basic issues and marketing practices. *Journal of Marketing Research* 18(2) 133-145.
- [44] Ring, S. M. & Van de Ven, A. 1992. Structuring cooperating relationships between organizations. *Strategic Management Journal* 13 483-493.
- [45] Rotter, J. B. 1967. A new scale for the measurement of interpersonal trust. *Journal of Personality* 35 615-665.
- [46] Rousseau D. M., Sitkin, S. B., Burt, R.S. & Camerer, C. 1998. Not so different after all: a cross-discipline view of trust. *Academy of Management Review* 23(3) 393-404.
- [47] Segars, A.H. 1997. Assessing the unidimensionality of measurement scales: A paradigm and illustration within the context of information systems research. *Omega* 25(1) 107-121.
- [48] Segars, A.H. and Grover V. 1998. Strategic information systems planning success: An investigation of the construct and its measurement. *MIS Quarterly* 139-163.
- [49] Senge, P. M. 1990. *The Fifth Discipline*. Currency Doubleday, New York.
- [50] Smith, J. B. & Barclay, D. W. 1997. The effects of organizational differences and trust on the effectiveness of selling partner relationships. *Journal of Marketing* 61 3-21.
- [51] Stewart, K. A. & Segars, A. H. 2002. An empirical examination of the concern for information privacy instrument. *Information Systems Research* 13(1) 36-49.
- [52] Straud D. W., Hoffman D. L., Weber B. W. & Steinfield C. 2002. Measuring e-commerce in net-enabled organizations. *Information Systems Research* 13(2) 115-124.
- [53] Straud, D. W. & Watson, R. T. 2001. Research commentary: Transformational issues in researching IS and net-enabled organizations. *Information Systems Research* 12(4) 337-345.
- [54] Tygar, J. D. 1998. Atomicity in electronic commerce. *Mixed Media* 32-43.
- [55] Wang, H. Q., Lee, M. K. O. & Wang, C. 1998. Consumer privacy concerns about internet marketing. *Communications of the ACM* 41 63-70.
- [56] Watson, R. T., Akselsen, S. & Pitt, L. F. 1998. Attractors: building mountains in the flat landscape of the world wide web. *California Management Review* 40(2) 36-56.
- [57] Williamson, O. E. 1993. Calculativeness, trust and economic organization. *Journal of Law and Economics* 30 131-145.
- [58] Zmud, R. W. & Boynton, A. C. 1991. Survey measures and instruments in MIS: Inventory and appraisal. K. L. Kraemer, ed. *The Information Systems Research Challenge: Survey Research Methods*, vol. 3, Harvard Business School, Boston, MA.

# Designing E-Commerce Product Innovation Strategies to Disrupt Existing Industries

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## Abstract

This paper develops a taxonomy of product innovation methods for entering e-businesses. These product innovation strategies share two common features: 1) a goal of disrupting the competitive structure of an existing industry, and 2) the use of digital technology combined with e-commerce to enhance or transform products and services. By disruption, the authors denote the attempt to destabilize the profit structure of an industry such that the incumbent firms can no longer earn economic rents above the industry average. Under these conditions, incumbent firms make no more than new entrants, surrendering their economic advantages. Theoretical frameworks in strategic management and the management of innovation and technology suggest that radical innovations are more likely to lead to destabilized markets. While this paper suggests that the dominant incumbent's advantage can be toppled, the paper does not suggest that the firm destabilizing the market will become the eventual market leader. While one can readily conceptualize the potential of e-commerce to disrupt existing markets, in practice few e-businesses have replaced entrenched competitors. Some of the failures of e-businesses to disrupt markets can be laid at the feet of strategies that were inadequately radical.

## 1. Introduction

E-commerce product innovation strategies are often proposed as a means for new firms to unseat incumbent businesses in established markets. With e-commerce growing at more than twice the rate of the global economy-- more than \$2 trillion was spent worldwide on e-commerce in the year 2000 [21], we expect an increasing number of new entrants will flock into e-markets. These new entrants must more fully understand the e-commerce competitive environment and its corresponding innovation strategies.

This paper develops a taxonomy of product innovation methods for entering e-businesses. These product innovation strategies share two common features: 1) a goal of disrupting the competitive structure of an existing industry, and 2) the use of digital technology combined with e-commerce to enhance or transform products and services. By disruption, the authors denote the attempt to destabilize the profit structure of an industry such that the incumbent firms can no longer earn economic rents above the industry average. Under these conditions, incumbent firms make no more than new entrants, surrendering their economic advantages [18]. The paper does not suggest that the firm destabilizing the market will become the eventual market leader; it suggests only that the dominant incumbent's advantage can be toppled.

### 1.1 Advantages of incumbent firms

The strategic management literature provides a research basis for understanding the advantages and vulnerabilities of incumbent firms. These advantages can flow from a firm's unique resource position as described by the resource based view of the firm [2] [17] [23], or they can flow from the firm's market position as described the industrial/organizational model of firm and market behavior [6]. The advantages and weakness of incumbent firms are compared in the context of both the resource-based view of the firm and industrial organizational economics.

Under the resource based view of the firm, incumbents are posited to have resources superior to entrants, resources that are valuable, rare, and costly to imitate. Among those resources commonly cited are: reputation, preferred sources of supply, and exclusive distribution agreements [3] [12].

Incumbent reputation works against entering firms who possess what is referred to as the liability of newness. Particularly in technology markets, buyers need to have confidence that they will be able to receive spare parts, service, and technology upgrades over the life of the product. Established firms have reputations that act

as a proxy of experience and legitimacy. New entrants need to have technologies or other benefits that are sufficiently superior to offset the customer's perceived risk of the entrant failing and stranding the customer with unsupportable technology. Additional resources frequently possessed by incumbent firms are 1) strong relationships with key existing suppliers and 2) an established and often exclusive access to distribution channels. By controlling key suppliers, incumbents are often able to secure higher quality. By controlling distribution, incumbents preclude entrants from entering traditional marketing channels.

Industrial organizational economics also suggests incumbent firms will have significant advantages. First, incumbents will likely have established entry barriers making it more costly for new entrants. Commonly cited entry barriers included first mover advantages, market power, brand recognition, economies of scope, economies of scale, and economies independent of scope and scale. Market and technological leadership can also deter new entrants [11].

In an industrial organizational framework, incumbents can be overtaken if they are not sufficiently flexible. This is particularly true in e-commerce where speed and change are the norm. New entrants can capitalize on incumbents' inflexibility and inability to learn and innovate. They can also benchmark and sidestep the incumbents to identify niche markets.

Strategy entails a set of commitments [8], often to specialized resources that cannot be utilized for other strategic purposes. Further, the network of a firm's business relationships forms a type of social exit barrier locking a firm into a set of supplier or distributor resources, thus, making it difficult to exit from unattractive arrangements. Also, managers often have difficulty abandoning strategies that have been successful for them in the past, even when the environmental context has changed [10]. Such complacency and inertia tend to create pockets of opportunities for new entrants. Not only can new entrants free ride the smoother path paved by incumbents, they can also capitalize on incumbents' mistakes and make the right moves in the new markets—moves that were difficult for the first-mover to envision.

Taken together, factors identified in the resource based view and the industrial/organizational model indicate that new entrants have the potential to overtake incumbent market leaders. Given existing resource endowments and market positions, however, the margin of error for product developers is small. To achieve industry leadership positions, entering firms must destabilize existing markets; they must take away their opponents basis of competitive advantage.

### 1.2 Product-design responses to incumbent power

Traditional product design frameworks often focus on one of two development strategies: incremental differentiation, or targeting a specific market niche. In incremental differentiation, the innovator attempts to develop a product or service whose benefits offset the

liabilities of newness in a sufficiently strong manner as to allow the innovator to charge a premium price, thereby offsetting some of the margin losses faced by entrants operating at a smaller than efficient scale.

An alternative approach is found in the hypercompetition literature [7]. Under hyper competition, firms choose strategies specifically designed to disrupt the normal functioning of markets. One such method is the introduction of a radical innovation. By definition, radical innovations obsolete knowledge [22]. If an innovation is sufficiently radical as to fundamentally change the way a customer does business, then traditional entry barriers fail to protect incumbents. Such disruption is likely in e-commerce for two main reasons. First, e-commerce is technology-driven and rapid technological change is the norm. For instance, when Iomega developed zip drives and high-capacity disks to replace the 3.5 inch floppy diskettes, computer hard drive manufacturers suddenly decided to build read/write hard drives with greater capacity, making zip drives and disks less marketable. Second, the product life cycle in e-commerce has become very short. The product developed of today may become irrelevant tomorrow in marketplace. Technological obsolescence is a common feature of e-commerce [1].

The high-velocity e-environment, with its inherent turbulence and uncertainty makes it easier to find windows of opportunity in which to launch new product designs. The rapidly emerging product launch windows in e-markets are a marked contrast to the pace of change in many traditional industries. In the auto industry for example, steam, diesel and internal combustion engines competed directly with each other for only about two decades; the next eighty years have belonged to the internal combustion engine and the now giant firms that mastered its technology. It is only in this decade that fuel cell technology has created a window of opportunity for smaller firms to compete with the giant automakers.

While one can readily conceptualize the potential of e-commerce to disrupt existing markets, in practice few e-businesses have replaced entrenched competitors. Some of the failures of e-businesses to disrupt markets can be laid at the feet of strategies that were inadequately radical. Early industry analysts expected electronic commerce to be sufficiently radical an innovation so as to obsolete traditional methods of conducting business. This proved to be far from the case. In the early stages of e-commerce, new entrants often employed off-the-shelf technologies, technologies that could be easily purchased by any competitor. As a result, incumbents were often able to adopt the same technology as entrants negating the newcomer's technical advantage.

## 2. Taxonomy of e-commerce product innovation strategies

This paper proposes a taxonomy of product/service innovation strategies specifically designed to disrupt markets, stripping incumbents of their resource based, and positionally based sources of competitive advantage.

The authors define product transformation as the creation of a product or service that generates a technological discontinuity [19]. For this paper, enhancement refers to strategies to incrementally improve core or ancillary goods or services in the new product bundle through e-business technology.

Taxonomies provide parsimonious descriptions of phenomenon that are useful in discussion, research and pedagogy [15]. The development of a taxonomy is beneficial because it reduces influences of confounding factors so that relationships and patterns can be detected [13] [14]. Identifying product/service innovation strategies with common features can help us understand how new entrants can destabilize markets and potentially unseat incumbent firms in established markets. Thus a taxonomy is useful both to researchers attempting to test relationships and patterns and practitioners who wish to exploit them.

### 2.1 Product service bundles

Central to the discussion of product innovation is the concept of product-service bundles. These bundles include the core product or service as well as ancillary services and expected future services [9]. A network administrator for example, purchasing computer system acquires the primary product of hardware and software; and ancillary services like training, documentation, and expected future services like the ability to purchase spare parts or additional training at some future date.

Firms do not compete on just products or services but on bundles of products and services. Product development teams clearly include enhancements to ancillary elements of the product in their research agendas.

### 2.2 Creating disruptive strategies

New product development teams can develop disruptive strategies for either the core product/service or the ancillary products/services. The core product is the primary instrument of customer value-creation; it is the customer's principal reason for doing business with the company. When products within an industry are similar, firms attempt to differentiate based on ancillary services, e.g., training, warranty, documentation, diagnostics, compatibility with other products, upward compatibility, etc. Given limited development resources, firms typically choose whether they will enhance or transform a core product or ancillary service. These choices lead to the matrix described in figure 1: The product innovation/market disruption matrix.

The product innovation/market disruption matrix identifies four unique product bundle strategies. They are: core and ancillary enhancement; core enhancement with ancillary transformation; core transformation with ancillary enhancement; and core and ancillary transformation. The paper describes the four strategies in detail and provides concrete examples for current e-commerce practice. The empirical literature and preliminary practitioner evidence suggest that firms wishing to disrupt incumbent market positions will be

most successful if they pursue a product transformation strategy. By definition, transformations require a radical innovation, thereby obsolescing knowledge. This obsolescence and weakens resource-based barriers like reputation and can even offset large positional barriers like economies of scale.

	Core Products		
	Enhance	Transform	
Ancillary services	Enhance	1 Enhance core and ancillary products	3 Transform core products/ enhance ancillary service
	Transform	2 Enhance core product/ transform ancillary services	4 Transform core and ancillary products

Figure 1: Disruptive product innovation strategies

### 2.3 Product digitization

In his influential research on technological innovation, Sahal [20] posited that as devices are made larger or smaller (scaled) the relationship between their structure and function changes. To Sahal, technological progress can be characterized as "learning by scaling." Product or service digitization represents the ultimate "scaling" of technology, taking physical goods and scaling them for instantaneous virtual delivery.

Choi et al [5] conceptualized e-commerce along three dimensions: products, processes, and agents. Firms considering e-business opportunities could chose a physical or virtual product; a physical or virtual process; or a physical or virtual agent/intermediary. Traditional firms had all three dimensions in the physical world; pure e-businesses had all dimensions in the virtual world. Implicit in Choi's model is the emerging capability of firms to digitize traditional products.

Product digitization is a radical innovation in that it obsolesces the economics of distance. To the extent a product is physical, it incurs logistics costs: inventory, warehouse, shipping, and warranty returns. Firms that can digitize products can compete globally at a cost advantage over traditional businesses. Similarly, physical agents typically accompany physical distribution. In addition to the direct costs of this model, there is the cost of recruiting, training, and retaining culturally sensitive agents who can represent products and services across cultures.

Service and agent digitization converts variable costs into fixed ones. Given fixed costs, firms with high volumes will achieve economies of scale and above normal returns when competing directly against firms with high variable costs. The cost advantages of digital intermediaries is ravaging traditional distribution

philosophy, rendering many distribution channels obsolete [16].

#### 2.4 Enhancement strategies

Firms may choose to enhance either their core product or ancillary services in order to gain competitive advantage. Enhancements, being less radical innovations than transformations, are easier for competitors to imitate and therefore tend not to form the basis for sustainable advantage.

National and international newspapers used to deliver single edition products worldwide; through product digitization and delivery they evolved to create regional editions that were delivered electronically to distributed-production facilities. These publishers integrated local materials like advertising into the regional edition for physical distribution. The result was an enhanced product. These same publishers have added enhanced services in the form of on-line tools for subscribers to accompany the printed page. These tools may allow subscribers to search full text of back issues or view the full set of regional editions.

Software firms have long known that they can reduce the cost of product distribution by digitizing product documentation. For large firms like IBM and Hewlett Packard, the savings over printing and distribution costs is substantial. Further, customers can have the enhanced features of search engines and advanced indexing. Like most incremental innovations however, once it has been introduced into the market, it is easily imitated.

Credit card issuers have added a number of enhancements to their services to merchants including instantaneous credit screening and card issuance, electronic accumulation and transfer for frequent flyer miles and internet security provisions. None of these features transform the industry, but they tend to make the innovator more competitive for the short-run.

#### 2.5 Transformation strategies

Transformation strategies are so radical that they render obsolete the existing basis of competition within an industry. Consider the case of the global recording industry. Questions of copyright aside, point-to-point file transfers combined with disk copying technology has ravaged the industry's existing product development and distribution framework.

From the perspective of the resource-based view of the firm perspective, incumbents should have had such enormous advantages as to blunt the threat of any entrant, especially small ones like Napster or Kazaa. Independent producers were unable to imitate the industry's large distribution networks. As a result, many talented artists choose to work with large record labels, even when they had artistic disagreements with the company, for fear of losing access to captive markets.

Electronic commerce has created a significant disruption in the recording industry. Independent producers can now distribute product over the Internet in small volumes and still be economically viable. With electronic distribution, small labels argue that artists can

be more profitable selling 15,000 items with them than through signing with giant labels selling millions of copies. The supergroup Backstreet Boys recently bolstered this argument in a lawsuit against their record label; after their sale of multiple million CDs, their label argued that the company has not made sufficient profit to justify extra payments to the band. Even for a small artist, industry analysts suggest a major label needs to sell 500,000 units to reach the break-even point.

Further, the very source of success in the record industry has created a high level of strategic inflexibility; record companies seem unwilling or unable to abandon their traditional strategies in light of new technology. Industry analysts note they have relied instead on copyright infringement suits to protect rents. However, sales revenues indicate this strategy has been particularly ineffective.

Similar radical e-commerce technologies are emerging in health care finance. U.S. hospitals and physicians have struggled for decades with case flow problems. Patients are required to pay the balance of their accounts after insurance companies have paid their share. The insurance payment is very unpredictable. The patient's co-pay amount is determined by a complex set of rules governing covered procedures, reasonable and customary charges, and accumulated health costs. The patient waits for the insurance industry to pay their share in order to establish their true out of pocket expense. In practice, the medical community has expected payment from individuals three to four months after the service has been provided. An entire billing and claims processing industry has developed in the US to help the medical community managing the patient billing and financing process.

An emerging radical e-business technology in healthcare has the potential to destabilize the patient financing industry. New services are being developed that would allow the instantaneous calculation of the outstanding account balance of an individual after insurance payments. The patient would be required to settle on the spot using cash or credit cards. The first card company to perfect the system will likely destabilize the billing, claims processing and patient financing industry.

Radical innovations are not without major shortcomings. First, radical innovations have a more complicated development process. Identifying breakthrough technologies is speculative work at best. Second, firms may create a radical technology that is disruptive to the industry but does not become the industry's dominant design. Third, radical designs need to be sufficiently beneficial to consumers for them to overcome exit barriers and other forms of inertia. Just having a radical design is not then a guarantee of market success.

### 3. Implications for research and practice

If radical innovations obsolete knowledge, and product digitization is a radical innovation, then e-businesses have the potential to destabilize markets. In a destabilized market, incumbent firms possess no better advantage than

entrants. Through radical innovation, entering firms can level the strategic playing field. For practitioners, this raises several important implications. New entrants may wish to focus greater resources on both search and development [22] and research and development.

Incumbent firms need to identify areas where product digitization would fundamentally change the industry and develop an a-priori strategy for responding to this challenge. It may be particularly valuable for firms to identify intelligent second-mover or late mover strategies that would allow them to benefit from resources like reputation while still competing on the new playing field.

Market entrants need to consider the value in disrupting the existing market. Without a discontinuous change, incumbent advantages in mature industries may be too powerful to overcome. Entrants need to consider methods of altering the fundamental customer value proposition through radical innovations like core product/service digitization.

Researchers face several key questions. While for purposes of simplicity the paper proposes an enhanced versus transformed innovation dichotomy, in practice innovations form a continuum from incremental through radical. An important question for researchers to determine is the extent to which an e-commerce innovation must be radical in order to disrupt an existing industry. Similarly, while a single enhancement will unlikely lead to competitive advantage, it is conceivable that a set of enhancements may combine to form an industry-destabilizing package. Researchers may wish to examine the effect of multiple product/service enhancements.

Due to the business risks associated with radical innovations, it is important for researchers to understand the role of intelligent late mover strategies. Intelligent late mover strategies have played an important role in the emergence of several Asian high-tech firms. It is unknown whether late-mover strategies can lead to competitive advantage in e-markets.

Theoretical frameworks in the management of innovation and technology and strategic management suggest that innovations like product/service digitization have the potential to obsolete incumbent advantages, thereby destabilizing existing markets. Given the potential rewards from overcoming incumbent positions, we anticipate more radically innovate e-business concepts in the future.

## References

- [1] Adobor, H. and McMullen, R. "Strategic partnering in e-commerce: Guidelines for managing alliances," *Business Horizons*, 2002, March-April: 67-76.
- [2] Barney, J. "Types of competition and the theory of strategy: Toward an integrative framework." *Academy of Management Review*, 1986,11, 791-800.
- [3] Barney, J. "Firm Resources and Sustained Competitive Advantage," *Journal of Management*, 1991,17(1), 99-120.
- [4] Bartlett, C and Ghoshal, S. "Going global: Lessons from late movers," *Harvard Business Review*, 2000,78(2), 132-142.
- [5] Choi, S. *The economics of e-commerce*. Indianapolis: Macmillan Technical Publications, 1997.
- [6] Conner, Kathleen R. "A Historical Comparison of Resource-Based Theory and Five Schools of Thought Within Industrial Organization Economics: Do We Have a New Theory of the Firm?" *Journal of Management*, 1991,17(1), 121-154.
- [7] D'Aveni, R. *Hypercompetitive rivalries*. New York: Free Press, 1992.
- [8] Ghemawat, P. *Strategy and the business landscape*. Boston: Addison-Wesley, 2000.
- [9] Kotler, P. *Marketing Management*. New Jersey: Prentice Hall, 1996.
- [10] Leonard-Barton, D. "Core Capabilities, Core Rigidities: A Paradox in Managing New Product Development." *Strategic Management Journal*, Summer Special Issue, 1992,13, 111-126.
- [11] Luo, Y. *Entry and cooperative strategies in international business expansion*, London: Quorum Books, 1999.
- [12] McGrath, R. "Discovering Strategy: Competitive Advantage from Idiosyncratic Experimentation," *Strategic Flexibility: Managing in Turbulent Environment*, Eds. Hamel, Prahalad, Thomas, O'Neal, Wiley, 1998, 351-370.
- [13] Miller, D. "Toward a new contingency approach: The search for organizational gestalts," *Journal of Management Studies*, 1981,18,1-26.
- [14] Miller, D & Mintzberg, H. *Organizations: A Quantum View*, Englewood Cliffs, N. J. Prentice-Hall, 1983.
- [15] Miller, J. And Roth, A.V. "A taxonomy of manufacturing strategies." *Management Science*, 1994,40(3),285-304.
- [16] Pitt, L., Berthon, P. and Berthon, J.P. "Changing channels, the impact of the internet on distribution strategy." *Business Horizons*, March/April, 1999,19-28.
- [17] Peteraf, M. A. "The Cornerstones of Competitive Advantage: A Resource Based View." *Strategic Management Journal*, 1993,14:179-191.
- [18] Prahalad, C.K. "Managing discontinuities: The Emerging Challenges," *Research Technology Management*; Washington; 1998, 41, 14-22.
- [19] Rosenbloom, R. and Christensen, C. M., "Technological Discontinuities, Organizational Capabilities and Strategic Commitments," *Industrial and Corporate Change*, 1994, 3, 655-685.
- [20] Sahal, D. "Technological guideposts and innovation avenues." *Research Policy*, 1985, 14, 61-82.
- [21] Torre, J and Moxon, R. "E-commerce and global business: The impact of the information and communication technology revolution on the conduct of international business," *Journal of International Business Studies*, 2001,32(4): 617-639.
- [22] Von Hippel, E. *The sources of innovation*. Oxford: Oxford University Press, 1998.
- [23] Wernerfelt, B. "A resource -based view of the firm." *Strategic Management Journal*, 1984,5, 171-180.

# Classifying E-Commerce Trust Seals: An Analytical Framework

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## Abstract

Trust seals are business assurance service in e-commerce. Vendors apply for trust seals to increase their trustworthiness. In this paper, we classify trust seals in five different categories: (1) comprehensive certificate provider, (2) seller evaluation service, (3) market evaluator, (4) market assurance service, and (5) niche service. We derive the five categories through three steps: (1) reviewing literature, (2) examining e-commerce processes, and (3) reviewing seal providers' documents. Our framework and analytical process can help e-commerce consumer to differentiate different types of seals and inspire seal provider to develop new services. We also identify many research opportunities for academics.

## 1. Introduction

In this paper we intend to answer the following questions. First, what does trust mean in the context of e-commerce? Second, can we create a simple framework to help people to differentiate the various types of seals? Third, what kinds of seals are currently available to consumers in e-commerce?

To answer our research questions, we proceed as follows: (1) From literature review, we create a theoretical framework (a classification scheme) identifying the role of trust in both traditional markets and electronic commerce. (2) We identify a list of the seals currently available in the United States. (3) We use our framework as an analytical tool to evaluate the seals identified in step 2. (4) Finally, we summarize our findings as a foundation for future research.

The results of the study will benefit both merchants and consumers. The framework used in this paper will help merchants to determine the seals that will be most effective in increasing consumers' trust, thus increasing sales. Our framework will also benefit consumers by helping them to discriminate among available seals. For the seal providers, our framework identifies opportunities for both new seal development and seal policy improvement. This paper will contribute to academics by identifying opportunities and directions for future research.

## 3. A Process Model to Identify the Sub-dimensions of Trust

Trust is a personal, organizational or mechanical status. It is people's willingness (for human systems) or a contract (for non-human system) to take risks in a relationship. Recently, researchers have recognized that trust is a multi-dimensional construct [20] [21] [22]. One method used to identify the sub-dimensions of trust is to identify the different types of trust-relationship and different risks associated with each type of relationship. For example, Sheppard and Sherman [22] studied the sub-dimensions of trust and developed a model to classify relationships in terms of form and depth. They note that there are four types of relationships: shallow dependency, shallow interdependency, deep dependency and deep interdependency. They also note that there are three types of risks associated with each relationship: (1) the risk of unreliability, (2) the risk of indiscretion, and (3) the risk of poor coordination.

Adopting the same method, we determine that we could develop a classification scheme if we could identify (1) the type of relationship being studied, and (2) the types of risks involved in the relationships. However, there may be many different ways to define the types of relationships and risks. We choose to classify relationships and risk by studying the e-commerce processes.

After reviewing Sheppard and Sherman [22], we adopt their definitions of risks involved in relationships and modify them for the e-commerce setting. We determine that there are essentially two types of risk involved in every trusting relationship: "risk of information disclosure" and "risk of task reliability". The risk of information disclosure is the risk that the trustee will not disclose relevant information fully and accurately. For example, sellers may not fully disclose their privacy policy. The risk of task reliability is the risk that the trustee will not perform the agree-upon tasks. For example, sellers may not deliver quality products or they may not be discrete with the buyer's private information.

Based on the above discussion, we develop Table 1 identifying 16 sub-dimensions of trust. Instead of describing the six possible trust-relationships, we simplify the framework by describing the responsibilities of three trustees, the buyer, the seller, and the market. Furthermore, since the objective of this paper is to help consumers differentiate among various seals, we exclude buyers as one of the interested trustees resulting in two trustees, the seller and the market.

Table 1. The 16 trust sub-dimensions

	Seller	Market
Trustee's Information Disclosure	1. Evaluation Phase	9. Evaluation Phase
	2. Purchasing	10. Purchasing
	3. Order-Fulfillment	11. Order-Fulfillment
	4. After-Sale	12. After-Sale
Trustee's Task Reliability	5. Evaluation Phase	13. Evaluation Phase
	6. Purchasing	14. Purchasing
	7. Order-Fulfillment	15. Order-Fulfillment
	8. After-Sale	16. After-Sale

Column 1 of Table 1 presents the two types of risk involved in e-commerce relationships: risk of information disclosure and risk of task reliability. Column two and three present the buyers' information disclosure risk and task reliability risk for each phase of the market process from the seller and the market respectively.

#### 4. An Exploration Analysis of Current Web Seals

We used Table 1 to analyze the available seals. The unit of analysis in this study is each individual seal. Some companies offer many different seals to cover different interest groups. We treated each seal as an independent unit. We used two methods to identify currently available seals. First, we utilized two popular search engines, google.com and the Microsoft search engine, to find seals. We used two key words: "trust" and "seal", in the queries. All seals identified with country postfix in their URL were excluded. Second, the search results were given to 200 students (both accounting and MIS majors) in the Fall 2001 semester at a large state university. The students were given the opportunity to earn bonus points by identifying additional seals. Table 2 lists all seals identified through this process and will be used as our sample for analysis.

Table 2. A list of popular Web seals

Sponsor	Seal Program
ABAecom	SiteCertain Seal
AICPA	Web Trust
The Council of Better Business Bureaus	BBB online reliability seal
	BBB Online privacy seal
	BBB Online kid's privacy
Better Internet Bureau Association	Quality Assurance
BuzRate.com	BizRate.com seal
Digital Signature Trust (DST)	TrustID Certificate
EPublicEye.com	Web Watch Dog
Entertainment Software rating Board (ESRB)	ESRB Privacy online
GeoTrust	True Site
Internet Content Rating	ICRA Label

Association	
Invisible Hand Software	PrivacyBot
PriceWaterHouseCoopers	The Better Web Program
Privacy Secure, Inc.	Privacy Secure Seal
Quality Testing Lab	QTL Licensing Program
SafeSerf	SafeSurf Logo
Safe Shopping Network	Tested for Safety Program
The Netcheck Commerce Bureau	Netcheck Membership seal
TRUSTe	Trustee Privacy
	E-Health Program
	Children's Seal Program
	EU Safe Harbor Program
Trustsecure	ICSA Security Certificate
VeriSign	SSL Certificate

Next we used Table 1 as our coding instrument. The three listed authors are the coders. We choose to limit the number of coder involved in the process for validity reason. For coding of latent content, too many coders involved in an early stage research project may result in wrong interpretations of the coding instrument [3, p. 311]. The coders obtain information about each seal by visiting its corresponding Web site. We coded each seal based on its functionalities or features as described in its publicly available documentation, such as FAQ, disclaimers, principles and guidelines, and/or application requirements etc. We used a simple "Yes" or "No" to describe if a certain seal provides assurance of a particular cell in table 1. After each coder completed all his/her evaluations, we compared our notes and identified the differences. We also set certain "rules" to resolve differences in coding (Table 3 is omitted to fit the page limit of this version).

Table 4a Comprehensive Certification Provider

	Seller	Market
Trustee's Information Disclosure	Evaluation Phase	Evaluation Phase
	Purchasing	Purchasing
	Order-Fulfillment	Order-Fulfillment
	After-Sale	After-Sale
Trustee's Task Reliability	Evaluation Phase	Evaluation Phase
	Purchasing	Purchasing
	Order-Fulfillment	Order-Fulfillment
	After-Sale	After-Sale

Table 4b Seller Evaluation Service

	Seller	Market
Trustee's Information Disclosure	Evaluation Phase	Evaluation Phase
	Purchasing	Purchasing
	Order-Fulfillment	Order-Fulfillment
	After-Sale	After-Sale
Trustee's Task Reliability	Evaluation Phase	Evaluation Phase
	Purchasing	Purchasing
	Order-Fulfillment	Order-Fulfillment
	After-Sale	After-Sale

Table 4c Market Evaluators

	Seller	Market
Trustee's Information Disclosure	Evaluation Phase	Evaluation Phase
	Purchasing	Purchasing
	Order-Fulfillment	Order-Fulfillment
	After-Sale	After-Sale
Trustee's Task Reliability	Evaluation Phase	Evaluation Phase
	Purchasing	Purchasing
	Order-Fulfillment	Order-Fulfillment
	After-Sale	After-Sale

Table 4d Market Assurance Service

	Seller	Market
Trustee's Information Disclosure	Evaluation Phase	9. Evaluation Phase
	Purchasing	10. Purchasing
	Order-Fulfillment	Order-Fulfillment
	After-Sale	After-Sale
Trustee's Task Reliability	Evaluation Phase	Evaluation Phase
	Purchasing	Purchasing
	Order-Fulfillment	Order-Fulfillment
	After-Sale	After-Sale

Table 4e Niche Service

	Seller	Market
Trustee's Information Disclosure	Evaluation Phase	Evaluation Phase
	Purchasing	Purchasing
	Order-Fulfillment	Order-Fulfillment
	After-Sale	After-Sale
Trustee's Task Reliability	Evaluation Phase	Evaluation Phase
	Purchasing	Purchasing
	Order-Fulfillment	Order-Fulfillment
	After-Sale	After-Sale

## 5. Some Preliminary Observations Toward Current Web Seals

A completed coding sheet is presented in available upon request. We classified Internet seals into five basic types (see table 4a to 4e).

We categorized the first type as "Comprehensive Certificate Provider." AICPA's WebTrust seal and PriceWaterhouseCooper's BetterWeb seal fall into this category. Both of these seals provide services similar to ISO9000 certificates that require trustees to document all their business practices and offer certificates after certain auditing procedures. We categorized the second type as "Seller Evaluation Services." Seals in this category include: BBBOnline's Reliability Program, ePublicEye seal, Privacy Secure Seal, Quality Testing Labs' QT Mark, and Netcheck.com evaluation service. This category represents the largest group in our study and provides assurance services about the seller but not the market. The third category includes SafeShoppingNetwork and BizRate.com. We labeled this group "Market Evaluator." This group differs from the previous group by providing certain assurances about market mechanism. Seals falling within this group evaluate task reliability but not

information disclosure. Unfortunately, the current two members of this group are themselves market builders, thus, rendering their assurances suspect.

The fourth category is the "Market Assurance Service" group. The group consists of Digital Signature Trust's Trust ID and VeriSign. Both companies sell either certification authority or Internet security software and services. Strictly speaking, they cannot be classified as Trust Seal since they do not act as third party evaluators. However, they do allow their customers to display their logos (this practice is very similar to the "Intel Inside" logo on many personal computers). This provides name recognition assurances to consumers by displaying the logo.

The last category is the "Niche Service" group. This group includes various privacy seals provided by TRUSTe, ESRB Privacy Seal, TruSecure Seal and ABAecom's SiteCertain Seal. Each of the seals in this group covers only one or two dimensions in our framework. Some of these seals provide even more narrow services targeting a particular industry or a particular interest group.

## 6. Conclusion

This research is exploratory in nature. The main purpose of this paper is to layout a foundation for future investigation on trust seals by creating a framework against which currently available seals may be evaluated. We identified currently available seals and used our framework to classify the seals into five categories. The categories are determined by the assurances they provide. The five categories are (1) comprehensive certificate provider, (2) seller evaluation service, (3) market evaluator, (4) Market assurance service, and (5) niche service.

Future research in this area could be aimed at answering the following questions. Do customers differentiate trust seals when they are conducting e-commerce activities? If they do, what underlying dimensions are they looking for? Can our framework raise the awareness and increase customers' capability in differentiating trust seals?

Our paper will extend the literature on trust in e-commerce. Currently this line of research is limited. However, the growing e-commerce market makes this line of research extremely valuable. We are sure that our efforts will inject energy to our research community and inspire new development in e-commerce.

## References

References are available in the full version of this paper.

# Collaboration: Spirit of Supply Chain Management

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## Abstract

The paper establishes the necessity for collaboration for effective supply chain management. We briefly explore some enablers and obstacles and propose the basic components of a strategy for enabling and overcoming these obstacles. Supporting technology for collaboration involves Supply Chain Management Software, Enterprise Resource Planning systems as well as the Internet for the communication platform. A brief discussion of the benefits that go beyond the bottom line, including customer demands and personalisation are noted.

Key words: Collaboration, Supply Chain Management, e-Supply.

## 1. Introduction

Many definitions of a supply chain exist, of particular relevance here because it illustrates the end-to-end processes within the supply chain, is (Granesan et al 1995) definition:

“A supply chain is a network of facilities and distribution options that performs the functions of procurement of materials, transformation of these materials into intermediate and finished products, and the distribution of these finished products to customers”

Traditionally, supply chains have existed in both service and manufacturing organisations and the processes within it are marketing, distribution, planning, manufacturing, and the purchasing, and they have operated independently having their own objectives which were often conflicting. For example, marketing’s objective could be based upon high customer service and maximum sales which could directly conflict with manufacturing operations/objectives, which are designed to maximise throughput and lower costs, with little consideration given to inventory levels and distribution capabilities. As a result of this, organisations have had no single integrated plan, creating a specific need for a mechanism through which different functions can be integrated together. The mechanism for this is supply chain management and this paper presents a case for collaboration as a necessary component for effective supply chain management.

## 2. The role of collaboration in supply chain management.

### 2.1 Supply Chain Management

The managing of the supply chain is nothing new, originating in the manufacturing and retailing sectors, with products like EDI being used for the sending of orders, production schedules and other information across private networks. In contrast the concept of “Supply Chain Management”, is indeed relatively new, and is applied to business in a much wider sense than that relating to the simple flow of goods used in the manufacturing process.

There is not a widely accepted definition of SCM, however, two suitable definitions are as follows:

“The management of materials, information and financial flows in a network consisting of suppliers, manufacturers, distributors and customers” (Youngman 2000a)

“Supply chain management is a collaborative-based strategy to link cross-enterprise business operations to achieve a shared vision of market opportunity”...“It is a comprehensive arrangement that can span from raw material sourcing to end consumer purchase” Quinn (1998)

These definitions underline two important points: firstly, the presence of a multi-party network of processes and secondly that it is a collaborative effort, which embraces all parties across the full length of the chain.

Keeme and Hafeez have explicitly noted the importance of co-ordination and collaboration: “Collaborative relationships have gained significant importance in recent years”, furthermore, “while engaged in a collaborative relationship organisations must be aware that they enter into a complex set of interdependencies..” Keeme and Hafeez [2001]

Therefore, our view of supply chain management embraces the various types of supply chains that lie between a fully vertically integrated firm, where it owns the entire material flow, and that where each channel member operates independently. As a consequence of this, coordination and collaboration between the various players in the chain is key to effective management of the supply chain (Warren 2001).

## 2.2 Collaboration: Enablers, Obstacles and Strategy

Following Uchneat [2001] collaboration in supply chain management means that all parties are working together toward common objectives; the process is characterised by the sharing of information, knowledge, risk, and profits, however before this can happen a culture change needs to take place, in order to redress the guiding philosophy from an "I win" to a "we win" approach.

Supply chain professionals have long suspected that true collaboration requires more than latest technology and that the key factors are people related. In order to expand on these factors that can deliver a host of competitive benefits we follow Anthony [2001] by considering the enablers that are required to be in place and how the obstacles, internally and externally, can be overcome.

Therefore not surprisingly, these enablers and obstacles have more to do with management style and interpersonal relationships than with technology. Indeed the enablers focus on collective co-operation whilst obstacles focus on the resistance to change. The difference is because people working within organisations reach a certain comfort level in their work and collaboration initiative disrupts that comfort level and requires a lot more effort (Quinn 2001). Examples of some key collaboration enablers and impediments are listed below.

Enablers:

- Common interest, clear expectations and good communications
- Mutual openness, trust and benefit sharing.
- Recognition of push and pull principles
- Leadership through co-operation, not punishment.

Obstacles:

- Limited view of the supply chain.
- Lack of Co-ordination in intra-organizational of resources
- Conventional accounting practices.
- Inconsistency of standards

Our Strategy builds on and enhances, Japuchi [3], the basic activities of a strategy for overcoming the obstacles and enabling the collaboration is as follows:

- Planning - the strategic portion of supply chain management. It requires a strategy for managing all the resources that go toward meeting customer demand for your product or service. A big piece of planning is developing a set of metrics to monitor the supply chain so that it is efficient, costs less and delivers high quality and value to customers.
- Choosing the best source of suppliers that will deliver the goods and services you need to create your product or service. This is achieved by developing a set of pricing, delivery and payment processes with suppliers and create metrics for monitoring and improving the relationships.

- Scheduling the activities necessary for production, testing, packaging and preparation for delivery. This is the most metric-intensive portion of the supply chain because it measures quality levels, production output and worker productivity.
- Logistics coordinating the receipt of orders from customers, develop a network of warehouses, pick carriers to get products to customers and set up an invoicing system to receive payments.
- Customer/Supplier Management Relationship The problem part of the supply chain. Create a network for receiving defective and excess products back from customers and supporting customers who have problems with delivered services.

## 2.3 Technology for enabling collaboration.

Without doubt, technology is a critical component of collaboration and the ability to exchange data among the supply chain partners and to gain visibility over product movement is fundamental to strategic supply chain management.

Many new technologies now exist to help companies in their collaborative efforts, with supply chain software solutions now able to promise trading partners instant connectivity and product availability across the pipeline (Cookson 2001). Recent advances in supply chain management software, coupled with the ease and cheapness associated with connecting to the Internet, now allow for streamlining of order management, manufacturing and logistics. These changes have been brought about as a result of three major issues of evolving supply chain management (Anthony 2000):

- The need to reduce the impact of time on supply chains.
- The creation of supply chain communities
- Cultivating customer and consumer intimacy (customer-centric supply chain)

Supply chain management solutions have become the logical extension from ERP, due to their increased flexibility and information flow on which to base critical decisions. According to a July 1997 study by the Gartner Group, key benefits stated include that, Whilst ERP systems provide a great deal of planning capabilities, the material, capacity, and demand constraints are all considered separately, in relative isolation of each other.

In contrast to this the more leading edge SCM products are able to consider all the relevant constraints simultaneously, and to perform real-time simulations of adjustments on them. It concludes that ERP systems have a harder time adding increased dynamic functionality because they are chiefly concerned with transaction processing, and have many more jobs to do than just SCM packages, whose leading products contain more enhancements such as visible maps of the entire supply chain, showing where problems are in contrast to ERP packages .

Despite considerable investments in ERP and supply chain planning systems, companies have realised that these systems are focused on internal processes, and that they now require solutions that are focused on inter-enterprise business processes. Today's SCM systems now encompass the entire production and sales cycle in a collaborative process with both customers and suppliers now incorporating such aspects as:

- f Match the demand to supply.
- f Allocate the supply to customers.
- f Commit the supply and promise orders.
- f Deliver to customers.
- f Collaborate with customers to forecast the next round of demand.
- f Collaborate with customers to focus demand.
- f Prepare a demand plan.

The communication platform for enabling collaboration is clearly the Internet which has had major implications on the way in which businesses now conduct business with one another and the consumer. Common terms such as e-commerce have arisen as a direct result of the innovation and change in supply chain management brought about by the latest technologies.

The Internet vastly changes the way in which businesses can procure products and services, in real-time and on a global basis. Riding on the back of the Internet we have seen the advent of 'hubs' or 'e-hubs', which are simply electronic market places. Technology provides a replacement for the middleman, becoming the mediator between the buyer and the seller, and it is these eMediators that will add tremendous value, particularly in the B2B marketplace (Fontanella 2001). The core benefits of hubs include cost savings through streamlining fax, phone and paper-based trade, and dynamic pricing as multiple suppliers negotiate cheaper prices, however many also incorporate supply chain management software providing transparency through the chain, allowing decisions to be made in real time (Anderson 2001).

### 3 Discussion

Therefore, we can see that this e-enabled Supply Chain Management now links all members of the supply chain to the information network, which improves effectiveness, reduces paperwork and pushes costs down (Fontanella 2001).

Whilst the biggest anticipated benefits will be financial, others will be achieved from the breaking down of functional barriers and less 'fire fighting', however for the benefits of collaboration to be achieved enablers must be implemented aggressively and obstacles should be addressed head on (Harreld 2001). The benefits of ESCM have been summarised by Quinn as shown in the Table 1 below. E-supply chain management enhances supply chain performance because tight coordination between business partners will result in all critical supply chain elements, such as information, transactions, and decisions becoming synchronized. The increased need for this change has been brought about due to the customers ever increasing

demands. They now look beyond cost as the sole arbiter of value, demanding innovation and personalisation of not only the products but also the associated services and delivery (Johnson 2001). By fully integrating your SCM functionality with your ERP systems this will provide three key benefits, quicker to market, cheaper and more flexible (Gossieux 2001).

Benefits	
Reduced inventory	Faster speed to market of new products
Improved customer service	Stronger focus on core competences
More efficient use of human resources	Enhanced public image
Better delivery through reduced cycle times	Greater trust and interdependence
Increased sharing of information and technology	Improved shareholder value
Stronger emphasis on supply chain whole	Competitive advantage over other supply chains

E-supply chain management provides companies with the unique ability to tap into performance and cost benefits and regardless of the type of marketplace, the benefits are many: lower product acquisition costs, lower procurement transaction costs, that ability to tap into almost unlimited supply sources to respond to changing market needs, and a means to profitably dispose of unused excess inventory (Anderson 2000).

The bottom line of the financial oriented benefits is expected to improve returns and increased shareholder value, whilst the non-financial benefits would be aspects such as increased trust, resulting in the sharing of information, ideas and technology. In short one benefit seems to compound another (Quinn 2001).

As for the future a recent report conducted by Jupiter Research predicts that 'e-supply chain management will continue to stay one of the hottest B2B technology fields'.

### References

- [1] Anthony, R (2000) "Cyber Supply", Electronic Business, June, <http://www.findarticles.com>, visited 01/08/2001
- [2] Anthony, T (2001) "Supply Chain Collaboration: Success in the New Internet Technology", <http://www.ascet.com>, visited 16/08/2001
- [3] Anderson, D (2001) "The Internet-Enabled Supply Chain: From First Click to the Last Mile", <http://www.ascet.com>, visited 16/08/2001

[4] Cookson, C (2001) "Linking Supply Chains to Support Collaborative Manufacturing", <http://www.ascet.com>, visited 07/09/2001

[5] Fontanella, J (2001) "E-Business and the Supply Chain: Is It Simply supply-chain.com?", <http://www.ascet.com>, visited 16/08/2001

[6] Graneshan, R & Harrison, T.P (1995) An Introduction to SupplyChainManagement", [http://silmaril.smeal.psu.edu/misc/supply\\_chain\\_intro.html](http://silmaril.smeal.psu.edu/misc/supply_chain_intro.html), visited 01/08/2001

[7] Gossieaux, F (2001) "Re-inventing Supply Chains: From Automation, to Integration, to Collaboration", <http://www.ascet.com>, visited 07/09/2001

[8] Harreld, H (2001) "Collaboration in supply chain management provides benefits", <http://www.infoworld.com>, visited 01/08/2001

[9] Johnson, E. M (2001) Supply Chain Synchronizing Through Web-Centric Product Content Management",

<http://www.ascet.com>, visited 07/09/2001

[10] Quinn, F (2001) "Collaboration: More Than Just Technology", <http://www.ascet.com>, visited 07/09/2001

[11] Quinn, F, J (1998) "Building a world-class supply chain", Logistics Management Distribution Report, June, <http://www.findarticles.com>, visited 01/08/2001

[12] Uchneat, J (2001) Collaborative E-Commerce: Driving Productivity in 2000 and Beyond", <http://www.ascet.com>, visited 07/09/2001

[13] Warren, L (2001) Handle with care (Wedgewood's supply chain)", Computer Weekly, March 8, <http://www.findarticles.com>, visited 01/08/2001

[14] Youngman, R (2000a) The increasing need for Supply ChainManagement", [http://www.youcan.bt.com/flash/scm/report\\_s/scm.html](http://www.youcan.bt.com/flash/scm/report_s/scm.html), visited 03/08/2001

# The Impact of Internet-Based Technologies on the Procurement Strategy

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## Abstract

The big company may spend millions of dollars of expenditure on indirect goods and services. However, much of them may be carried out locally or divisionally, bypassing central guidelines. From a corporate perspective the fragmented procurement resulted in slow and expensive processes and excessive product costs due to poor leverage of buying power. The greater information processing capability achieved through the use of technology, especially Internet-based procurement systems, will enable significant cost improvements and leverage to be obtained through a more strategic approach to management of the typically routine and repetitive tasks with a low unit value, high variety of goods and services, but relatively high frequency. According to the researches, a 10 percent reduction in purchase costs can easily lead to a 50 percent rise in profit margin. This paper addresses the issue of how the Internet-based technologies will impact on the procurement strategy. I believe that the radical change in the Internet will give rise to new marketplaces, which may have the largest impact on procurement. The benefits to aware impacts come not only through direct cost savings but also through the improved efficiency of companies rethinking how they operate.

## 1. Introduction

Emerging technologies, such as the Internet and Web, are bringing the promises to change the picture of costly, time-consuming, and inefficient procurement processes by enabling major improvements in terms of lower administrative overhead, better service quality, timely location and receiving of products, and increased flexibility. With most organization spending at least one third of their overall budget to purchase goods and services, procurement holds significant business value (Zenz & Thompson, 1994; Killen & Kamauff, 1995). Meanwhile, growing pressures from increasingly competitive markets all around the world reinforce the need to reorganize and streamline inefficient procurement procedures.

IT-based tools have been introduced to support production procurement and supply chain operations. However, procurement activities in the non-production items have long under-estimated on an organizational level as well as with respect to the use of IT. Because of little process standardization and a majority of manual activities, the non-production procurement is often a poorly managed, uncoordinated, and non-valued activity (Croom, 2000; Gebauer & Zagler, 2000). Available IT

systems usually do not cover the full process or are very expensive to set up. Internet and Web-based applications promise alternatives that are cheaper and easier to set up. Consequently, procurement function is facing significant reengineering and change management challenges.

This paper addresses the issue of how the Internet-based technologies will impact on the procurement strategy. I believe that the radical change in IT will give rise to new marketplaces, which may have the largest impact on procurement. The benefits to aware impacts come not only through direct cost savings but also through the improved efficiency of companies rethinking how they operate. I will provide an overview of procurement processes and some of the activities that organizations had undertaken to improve performance, then taking a look at currently available Internet- and Web-based technologies, and the opportunities that they open. The impacts and obstacles are also discussed.

## 2. Research Background

The corporate procurement has traditionally been separated along two dimensions: the direct or production-oriented procurement and indirect or non-production-oriented procurement. Direct procurement generally refers to the purchasing of items that immediately enter a manufacturing process, such as the parts that are assembled into a car or computer. Indirect procurement includes everything that is not covered by direct procurement. In addition to so-called maintenance, repair, and operations (MRO) supplies that are consumed in the production process and required to keep up the manufacturing process, indirect procurement also includes items, as diverse as office supplies, computer equipment, promotional material, travel and other services (Segev, Gebauer, & Farber, 2000). Other researchers also include items in the indirect category such as training materials, accessories, temporary staff, public relationships, entertainment (Croom, 2000) and contract workers and consultants (Moozakis, 2001).

The direct procurement has been emphasized on and treated differently than indirect procurement. Compared to direct procurement, indirect procurement covers a wider range of products and services, typically involved a larger number of buyers (possibly every employee, for example, office supplies), and is much less predictable with respect to buying volume and frequency. Add the fact that it is often not regarded of strategic relevance but rather as a clerical function, and it comes at no surprise that the businesses processes are typically not well standardized, most manual, and as a result inefficient and non transparent (Gebauer & Segev, 2001).

Incidentally, the difference between direct and indirect procurement also shows in organizational charts: direct procurement often reports to a Vice President of Supply Chain Operations (or similar) while indirect procurement might fall into the responsibility of the finance function. The line of management for both areas only meet at the level of the Chief Executive Officer. In the literature, the indirect products and services, variously known as MRO (maintenance, repair, and operation) items, have received little attention, as by far the dominant focus of the purchasing literature has been the management of production item procurement. However, a big company may spend millions of dollars of expenditure on indirect goods and services. Much of them may be carried out locally or divisionally, bypassing central guidelines. For example, a large manufacturer bought office supplies from as many as three hundred suppliers, more or less regularly. Nobody was in control of the overall process and each business unit had its own procedures in place. From a corporate perspective the fragmented procurement resulted in slow and expensive processes and excessive product costs due to poor leverage of buying power (Nelson, Moody, & Stegner, 2001). According to PricewaterhouseCoopers, a 10% reduction in purchase costs can easily lead to a 50% rise in profit margin.

The greater information processing capability achieved through the use of technology, especially Internet-based procurement systems, will enable significant cost improvements and leverage to be obtained through a more strategic approach to management of the typically routine and repetitive tasks with a low unit value, high variety of goods and services that constitute the main category of MRO (maintenance, repair, and operation) items. However, most information processing and communication around procurement in the organizations is still based on paper and telephone (Segev, Gebauer, & Farber, 2000). The new procurement systems (i.e. E-procurement) allow employees to order goods directly from their PCs, either through an Intranet or a website. Orders are automatically channeled to suppliers, often via a hub that acts as a host for their online catalogues. The catalogues hold the companies negotiated prices, as well as authorization rules that ensure the right people buy only what they are allowed to. When employees put the job out to tender, it will come back with a list of three or four suppliers. Operators of procurement hubs will increasingly scour the world for new low-cost suppliers, to offer a better service for their purchasing customers. They will check out these suppliers for quality and integrity, if necessary build catalogues for them, and plug them into their systems.

E-procurement system allows employees to combine catalog from several suppliers, check the availability of items, place and track orders, and initiate payment over the Internet. It does not mean just putting purchasing decisions online, but also means linking suppliers into the purchasing network and broadening the range of employees who can carry out transactions. Therefore, e-

procurement is not an example of computerizing the old manual process, but of re-engineering the process itself.

How will the Internet-based technologies impact on procurement strategy? Does Internet mean just doing the same things faster and cheaper? This study attempts to answer those questions. There are also three goals in which this study intends to pursue:

1. Evolve from buying of simple indirect products to sourcing of complex direct products  
Most firms are currently stuck at the first stage of procurement, i.e. simple automation transaction. After starting with non-production related, indirect or MRO (maintenance, repair, and operation) purchases, companies will gradually transfer what they have learned to other parts of the business.
2. Extend from large companies to small or medium-size companies  
Similar to traditional EDI applications, early e-procurement projects have been undertaken by large organizations. In the future, the small companies will also benefit from these new technologies.
3. Increase automation and flexibility  
The companies often experience great difficulties to keep up with the rapidly advancing technological development. Not prepared for the changes, lots of people charged with procurement have little or no experience in buying online (Ramsdell 2000). A number of factors have prevented a shift from focusing on automation to focusing on flexible e-procurement solutions. New systems should be able to increase automation and flexibility to cope with exceptional demands and inexperienced workers.

### 3. Literature Review

The related literature will be reviewed in this section.

#### 3.1 Procurement vs. Purchasing

Procurement includes all activities involved in obtaining materials, transporting it, and moving it towards the production process (Segev, Gebauer, & Beam, 1998). Purchasing is the act of buying and services, represents a core element of procurement.

Procurement processes take on many different forms in reality. Considering the types, uses, and the value of the goods purchased, three categories of procurement have been distinguished (Hough & Ashley, 1992; Zenz & Thompson, 1994):

- n Procurement of raw material and production goods is usually characterized by large quantities, high frequencies, and important and unique specifications; just in time is often critical.
- n Procurement of maintenance, repair, and operation (MRO) supplies is characterized by low unit cost and high variety, but relatively high frequency; examples include office supplies.
- n Procurement of capital goods means dealing with goods of high value at low frequency (e.g. new factories) and/or procuring items outside the regular

purchasing process, often because of convenience or speed requirements.

Close supplier relationships are particularly relevant for direct procurement (raw materials or production goods) where the quality and availability of suppliers can be of critical importance (Lutz, 2001). Company typically spends several years to establish the relationship and to ensure the supplier meets the high quality standards. The unknown suppliers are unthinkable in this context. For indirect procurement (MRO and capital goods), efforts to consolidate the supply base and to establish relationships with preferred suppliers often consider cost rather than quality and availability (Cousins, 1999). Buying firms expect better product prices and less costs to manage the supplier base.

These three types of procurements also involve in three main categories of costs (Gebauer & Zagler, 2000). In the first category, the cost of procurement of raw materials is the product cost (and quality). To ensure consistent quality, the pre-selection of suppliers and active supplier management are critical activities of the sourcing cycle. The involvement of suppliers in target costing activities and collaborative design has proven useful to limit total project cost. In the second category, the cost of procurement of MRO items is the process cost. In this category, the process costs may equal or even exceed the product cost. Therefore, the price is critical. The third category is the technology cost for capital goods. Typically, the characteristics of capital goods are high complexity, innovation, and strategic relevance. Therefore, the range of available supplies is typically very limited (Brown, 2000).

### 3.2 Strategic vs. Transactional Tasks

Procurement activities can also be categorized: long-term-oriented strategic and short-term-oriented transactional activities (Segev, Gebauer, & Beam, 1998). Long-term-oriented, strategic tasks include sourcing activities, identifying vendors, and establishing and managing supplier relationships, as well as contract negotiation and management, but also the design and implementation of buying procedures, and financial and asset management. Activities are long-term oriented and the resulting supplier relationships often last for many years. Short-term-oriented transactional tasks are mostly clerical order-related activities.

### 3.3 Sourcing vs. Buying

Many purchasing organizations distinguish between activities of sourcing and buying tasks (Dobler & Burt, 1996). Sourcing processes cover more than just one or a few individual buying operations and include:

- n Market Intelligence
- n Demand forecast and planning
- n Identification of suppliers
- n Requests for quote and bidding
- n Negotiation of terms of contract
- n Selection of sources and finalizing of contract
- n Supplier management

Buying processes typically refer to single transactions only and include activities such as:

- n Selection of product and supplier, from catalog or other sources
- n Submission of internal requests and management approval
- n Submission of purchase orders to pre-approval supplies
- n Delivery, payment
- n After-sales support and customer service

## 4. Theoretical Foundations

The benefits to the firms deploying Internet technologies include: increased efficiency of order processing, reduced costs due to just-in-time inventory management, locked in trading partners because of the difficulties competitors faced once a network is in place, and greater ability to customize products and services based upon information arising from the transactions carried by the network (Cash & Konsynski, 1985; Johnston & Vitale, 1988). The internet will also increase the efficiency of supply chain by facilitating inter-organizational information sharing, reduce the length of the supply chain by making it easier to locate suppliers, and help handle situations of unforeseen demands better (Gebauer & Segev, 2001).

### 4.1 Supply Chain Management

Supply chain management (SCM) has been used to partner with suppliers and to integrate logistics functions and transportation providers to efficiently and effectively manage the value chain. Most of the recent literature on supply chain management focuses on manufacturers' attempts to integrate processes and form alliances with suppliers to more efficiently and effectively manage the purchasing and supply function.

The supply chain management philosophy expands the internally focused integrating activities of logistics by bringing multiple organizations along the supply chain together with the common goals of efficiency and end-consumer satisfaction (Harwick, 1997). SCM creates a virtual organization of independent entities to efficiently and effectively manage the movement and transformation of materials, components, products, and services along the supply chain until final delivery to the end user (Croom, 1998). Thus, SCM integrates a number of key functions, including purchasing, demand management, manufacturing planning, and materials management, throughout the supply chain.

The short-term objective of SCM is primarily to increase productivity and reduce inventory and cycle time. To realize this objective, all strategic partners must recognize that purchasing function is a crucial link between the sources of supply and the organization. Indeed, the origin of SCM can be traced back to efforts to better manage the transportation and logistics function. In this respect, SCM is synonymous with integrated logistics systems that control the movement of goods from the suppliers to end customers without waste (Ellram, 1991; Ellram & Billington, 2001).

Integrated logistics systems seek to manage inventories through close relationships with suppliers and transportation, distribution, and delivery services. A goal is to replace inventory with frequent communication and sophisticated information systems to provide visibility and coordination. In this way, merchandise can be replenished quickly in small lot size and arrive where and when it is needed (Handfield 1994).

#### 4.2 Strategic Networks

Strategic networks are defined as the long-range, deliberate, cooperative, and goal-oriented organizational forms among distinct but related organizations that enable such network member organizations to sustain competitive advantage vis-à-vis their competitors outside the network (Jarillo, 1993). Wingand, Picot and Reichward (1997) emphasized strategic networks as a distinct organizational form, that is, as being separate from hierarchy and market.

Networks optimize communication, and a more efficient exchange of information becomes possible. As Powell (1990) stated, information passed through networks is thicker than information obtained in the market (since the price mechanism tends to treat information as a commodity and thus tries to make it as scarce as possible) and freer than that communication in a hierarchy (since information is not filtered as clearly through power relationships). Therefore, network organizations combine the advantages of hierarchies, such as better control and coordination of actors, with the advantages of small, independent companies—who has more innovative abilities, tend to be in closer contact with the market, and more flexible, with smaller staffs, fewer intermediaries, and lower overhead.

Malone, Yates, and Benjamin (1987) believe that the development of inter-organizational electronic networks would increase the numbers of buyers and sellers. The use of open information systems may be seen to provide greater levels of information to buyers, thereby opening up greater competitiveness between providers. In addition, they argued that the use of electronic communication links between firms could reduce both the costs of coordinating economic transactions and the costs of coordinating production. As a result, the lowered coordination costs would encourage more outsourcing, enabling firms to buy goods and services less expensively than by producing them in house (Malone, 1987; Malone et al., 1987; Malone et al., 1989).

Existing evidence at the industry level indicates that increases in investment in information technology are associated with a decline in average firm size and a rise in the number of firms (Brynjolfsson, Malone, Gurbaxani, & Kambil, 1993). It may be expected that greater information availability will lead firms to increase their level of outsourcing. As a consequence, an increase in the proportion of bought-out goods and services will place an increased strategic emphasis on the purchasing process.

#### 4.3 Transaction Cost Theory

Economists have classified transaction among and within organizations as those that (a) support coordination between multiple buyers and sellers, that is, market transaction, and those (b) supporting coordination within the firm, as well as the industry value chain, i.e. hierarchical transactions (Wigand, 1997). Marketing hierarchy progressing from manufacturer to wholesaler, retailer, and consumer is associated with transaction costs. Transaction costs include the costs of searching, bargaining, coordinating, and monitoring that companies incur when they exchange goods, services, and ideas (Benjamin & Wigand, 1995; Wigand, Picot & Reichwald, 1997).

The major force driving electronic commerce is the ability of networks to reduce transaction costs (Auger & Gallagher, 1997; Garcia, 1997). Capitalism depends on information to allocate resources efficiently. When business can access the best available information at the most appropriate moment, they can reduce their costs and enhance their productivity. Similarly, when buyers and sellers can easily locate one another and have a good idea of what they can expect in terms of quality and prices, they are more likely to engage in trade. The ever-increasing and innovative use of the Internet or Web to conduct business is clear example of firms' desires to reduce transaction costs. Thanks to information technology, the evolution from separate databases within the firm to linked databases between firms to shared databases between firms, transaction costs are indeed falling rapidly (Wigand, 1997). Malone et al. (1987) also suggested that the communication effect via information technology and a tighter electronic linkage between buyers and sellers may lead to reduced transaction costs.

#### 4.4 Collaborative Commerce

Michael Hammer (2000) defined collaborative commerce as "it is multiple companies working together to achieve better results than they could together" (p.190). Clearly, the Internet is the key enabler of that. The corporate purchasing has been shaken by those collaborative activities. A new category of "buy-side" software from vendors like Ariba and CommerceOne appeared on the scene. This software allows companies to automate and streamline the purchase of indirect, everyday supplies that not used in products. Then came net markets, with their tantalizing promise of even greater cost saving in the purchase of direct products—the raw materials that actually go into a product.

Recently, several hundred independent exchange have opened for business and announced plans to build their own Web-based marketplaces. These online markets create new ways of doing business in traditional industries such as papers and chemicals, where the process of buying and selling commodity-like products. Buyers and sellers can meet on a virtual trading floor and transact as quickly and efficiently.

We see that the first wave of Internet-enabled collaboration focused on the supply chain, as companies collaborated with their customers, suppliers, and

intermediaries (Bowles, 2000). But the second wave is extending to enterprises with which a company previously had no relationship. Collaborative commerce is rapidly becoming the norm. Over the next years, increased business process integration will lead companies to a big payoff—a more synchronized supply chain, which yields better customer service, higher quality products, lower inventory and faster delivery.

## 5. The potential of Internet-based Procurement Systems

With procuring processes typically involving a large amount of information processing and communication, procurement is well suited for IT support and automation throughout all its steps.

Early initiatives to introduce Internet technologies to support procurement concentrated on the automation of highly structured processes. Desktop purchasing systems (DPS) extend traditional EDI systems with user friendly, browser-based interfaces, increased flexibility and automated workflow, well suited to facilitate end-user empowerment and self-service. Based on electronic catalogs as a central data repository, these systems are readily available and well suited to automate highly repetitive activities, as they prevail in the category of process cost oriented procurement (low unit value and high variety items purchased at high frequencies, such as MRO items). In many cases, the operational gains from reduced process costs and lead times allowed procurement departments to reduce their administrative workloads and free time and resources for strategic sourcing activities.

Recent developments are most prevalent in the area of Internet-based exchange, be they horizontal or industry specific (Kaplan & Sawhney, 2000; Phillips & Meeker, 2000). While horizontal exchanges connect market participants of the same function, such as automotive industry, exchanges provide information and services to all members of a particular industry. The other examples of trade exchange include MetalSite, e-STEEL, MetalSpectrum, GlobalNetExchange, WorldWideRetailExchange (retail), and E2Open (electronics). Although the boundaries are usually indistinct, exchanges tend to provide less automation than DPS but cover a wider area of products, typically procured at low frequency with a focus on product cost and quality. Also, solutions oftentimes support only a few aspects of the procurement process, such as supplier identification (supplier directories), or obtaining access to product information.

## 6. Research Methodology

The first and most important condition for differentiating among various research methodologies is to identify the type of research question being asked (Strauss & Corbin, 1990; Yin, 1994). The primary question of this research is, how will the Internet-based technologies impact on procurement strategy. According to Yin (1994), case studies are preferred when “why” and

“how” questions are being posed, when the investigator has little control over events, and when the focus is on contemporary as opposed to historical phenomena (p. 1). This research aims to answer the question of how, and because Internet technologies is a contemporary phenomenon and changes rapidly, the investigator cannot expect any control. Therefore, the case study methodology will be applied in this study.

### 6.1 Data Collection

The principle of data collection is to use multiple sources of evidences. Any finding or conclusion in a case study is likely to be much more convincing and accurate if it is based on several different sources of information, following a corroboratory mode (Yin, 1994). Evidences in this study will come from three sources: semi-structured interview, Website visits, and document review. Semi-structured interviews and web site visits were the primary vehicle for investigation. Documents, secondary data collection were also applied to support and complement the primary approach. The convergence of results between multiple data collection sources enhances confidence that the results are valid, and weaknesses in one method are compensated by the strengths of another.

Semi-structured interviews were carried out in the fall of 2000. More than one person per firm was interviewed to cross-check for any inconsistencies in interview responses and to strengthen the data reliability. The participants located in Minnesota came from companies' Chief Operation Officers, purchasing managers and e-procurement experts. The interviews employed open-ended questions.

Although on-site interviews can reduce the researcher's distance from the phenomena and provide insights, interviews are subject to problems of bias, poor recall, and poor or inaccurate articulation (Yin, 1994). A reasonable approach is to corroborate interview data with information from other sources. Website visit is the second resource of collecting the original data. It will be undertaken in an attempt to bring about greater understanding of the background and process of procurement. A review of the specialized industry magazines and conferences was also used. Several other sources were reviewed to safeguard the reliability and validity of the secondary data. I coded data from all interview responses using typical content analysis procedures (Lincoln & Guba, 1985; Strauss, 1987; Taylor & Bodgan, 1984).

## 7. Impacts

The impacts are examined as below.

### 7.1 Role Change in Purchasing Department

There are changes to business practices and organizational structures over the next years as e-commerce solution becomes more mature and more widespread. As a general development we see the role change between end users and purchasing department, i.e. new procurement system will continue to either automate purchasing operations or help push them down to the end

user, allowing the purchasing department to concentrate more on strategic and managerial tasks, such as partnership relationships, long-term supply contract. Since employees can purchase directly through their Web access, purchasers no longer need to process orders, invoices, or chase delivery. As a result, purchasing department will become composed of mostly managers, and less of clerks, secretarial staff, and administrative support. Additionally, the determining factor of geography will reduce, freeing organizations to obtain the best deal and the most appropriate products from anywhere on the globe.

### **7.2 Convergence between Direct and Indirect Goods**

The division between direct and indirect goods will be blurred. E-procurement encourages commoditisation (brand details are often stripped from the catalogues), which means they will be ideal for standard production items (nuts, bolts, paper clips, and so on), as well as non-production indirect goods. The real distinction will be between purchases that can be commoditised, and those that cannot.

### **7.3 Supply Base Reduction**

Small supplier bases could go into reverse. This will not happen for critical components, where the need for ever-closer collaboration will continue to shrink supplier numbers. But if you are buying paper clips, why not cast your search as wide as possible? Reverse auctions will allow you to spread the net far more widely, and the Internet is excellent at handling complexity. This is not to say that the end buyer will necessarily deal with more suppliers-but he will be dealing with a bigger supplier base. The consolidation of suppliers will appear.

### **7.4 Increased Procurement Control**

The variety of MRO items consider difficulty in terms of developing specialist knowledge regarding product and service technical characteristics, and supply market conditions. The ability to consolidate and categorize suppliers, services, and MRO goods is seen as an enabler in the move toward greater professional contribution to MRO procurement. In addition, the centralized purchasing function was able to exert greater control over sources of supply, purchase price, and inventory policy. Organizations will be able to manage their MRO low-value and high variety items in a more strategic manner through such action as the establishment of single-source arrangements, consolidation of commodities and services, and increased buying power over the supply base.

### **7.5 E-auction**

The new generation MRO, electronic auctions might start to play an important role. A prospective purchaser could dial in and see the spot price of paper, chairs, or office supplies and determine whether to purchase. In the future, next generation auctions will also feature more complex items and allow matching of supply and demand not only with respect to price, but also for features such as service, quality, or speed of delivery.

### **7.6 E-bidding**

Writing up an electronic Request for Quote and submitting it to the electronic marketplace will become easy for buying organizations. Suppliers would be able to electronic contact each other, negotiate a team-based approach, and automatically respond to the Request for Quote.

## **8. Obstacles**

The following obstacles are discussed.

### **8.1 Security Concerns**

The issue of security is a major concern, especially in the context of electronic payments. The capability of any system to provide secure data transfer was regarded as a major criterion for both existing and potential users of e-procurement systems.

### **8.2 Inefficiencies in Locating Information**

This lack of interoperability and the lack of standards make it difficult to pull all buyers and suppliers together into a single protocol or a few marketplaces for buying and selling. Despite its steady growth, the current use of Internet-based technologies has not yet reached critical mass.

### **8.3 Staff Resistance**

Sometimes, the purchasing staff will resist online solution because, not unreasonable, they detect a threat to their job security. In fact, their roles do change dramatically because they are freed from burdensome clerical labour which takes up 70 percents of their time in manual systems and allowed to put their real skills into practice by negotiating contracts and monitoring supplier performance. Also, organizations used to rely extensively on interpersonal communication (telephone, face-to-face negotiation, or fax, etc.). The habits are hard to change. The staff resistance will increase.

### **8.4 Lack of Top Management Support and Vision**

This is understandable, because not even researchers and market analysts are yet sure of the exact direction electronic purchasing will move. There is a long road from the friction-free e-procurement to the reality. However, the successful e-procurement is a top-down process that requires a champion and a visionary at the boardroom table who can grasp the strategic potential of the procurement issue.

## References

- [1] Auger, P., & Gallagher, J. M. (1997). Internet-based sales presence for small business. *The Information Society*, 13(1), 55-74.
- [2] Benjamin, R., & Wigand, R. (1995). Electronic markets and virtual value chains on the information superhighway. *Sloan Management Review*, 36(2), 62-72.
- [3] Bowles, J. (2000). E-procurement. *Forbes*, 189-216.
- [4] Brown, R. (2000). Bechtel's approach to E-procurement. Haas School of Business, University of California, Berkeley.
- [5] Cousins, P. D. (1999). Supply base rationalization: Myth or reality? *European Journal of Purchasing and Supply Management*, 5(3/4), 143-155.
- [6] Croom, S. R. (2000). The impact of Web-based procurement on the management of operating resources supply. *The Journal of Supply Chain Management*, 36(1), 4-11.
- [7] Dobler, D. W., Burt, D. N. (1996). *Purchasing and supply management* (6<sup>th</sup> ed.). New York: McGraw Hill.
- [8] Ellram, L., Billington, C. (2001). Purchase leverage considerations in the outsourcing decision. *European Journal of Purchasing and Supply Management*, 7, 15-27.
- [9] Fisher, A. (2001). Understanding E-procurement. *Financial Times*, 6-8.
- [10] Garcia, D. L. (1997). Networked commerce. *The Information Society*, 13(1), 9-41.
- [11] Gebauer, J., Zagler, M. (2000). Assessing the status quo and future of B2B e-commerce. Haas School of Business, University of California, Berkeley.
- [12] Gebauer, J., Segev, A. (2000). Emerging technologies to support indirect procurement: Two case studies from the petroleum industry. *Information Technology and Management*, 1, 107-128.
- [13] Gebauer, J., Segev, A. (2001). Changing shapes of supply chains-How the Internet could lead to a more integrated procurement function. Haas School of Business, University of California, Berkeley.
- [14] Hammer, M., Champy, J. (1993). *Reengineering the corporation: A manifesto for business revolution*. New York, NY: Harper Business.
- [15] Hough, H. E., Ashley, J. M. (1992). *Handbook of buying and purchasing management*. Englewood Cliffs, NJ: Prentice-Hall.
- [16] Jarillo, J. C. (1993). *Strategic networks: Creating the borderless organization*. Jordan Hill, England: Butterworth-Heinemann.
- [17] Kaplan, S., Sawhney, M. (2000). E-hubs: The new B2B marketplaces. *Harvard Business Review*, 78(3), 97.
- [18] Killen, K. H., Kamauff, J. W. (1995). *Managing purchasing: Making the supply team work*. New York, NY: McGraw Hill.
- [19] Lutz, J. (2001). Procurement strategies for eBusiness. Haas School of Business, University of California, Berkeley.
- [20] Malone, T. W., Yates, J., & Benjamin, R. I. (1987). Electronic markets and electronic hierarchies. *Communication of the ACM*, 30(6), 484-497.
- [21] Malone, T. W., Yates, J., & Benjamin, R. I. (1989). The logic of electronic markets. *Harvard Business Review*, 67(3), 166-170.
- [22] Moozakis, C. (2001). E-procurement for services-Texas Instruments uses Clarity to better manage contract workers. *InternetWeek*, 876, 17-18.
- [23] Nam, C. C. (1999). Increase your profit margin through electronic procurement. *Journal of Internet Purchasing*.
- [24] Nelson, D., Moody, P. E., Stegner, J. (2001). *The purchasing machine: How the top ten companies use best practices to manage their supply chains*. New York: Free Press.
- [25] Phillips, C., Meeker, M. (2000). *The B2B Internet report: Collaborative Commerce*.
- [26] Powell, W. W. (1990). Neither market or hierarchy: Network form of organization. In B. M. Staw & L. L. Cummings (Eds.), *Research in organizational behavior*, 12(pp. 295-336). Greenwich, Conn: JAI Press Inc.
- [27] Ramsdell, G. (2000). The real business of B2B. *McKinsey Quarterly*, (3), 174.
- [28] Segev, A., Gebauer, J., & Beam, C. (1998). Procurement in the Internet Age-Current practices and emerging trend. Haas School of Business, University of California, Berkeley.
- [29] Segev, A., Gebauer, J., & Farber, F. (2000). The market for Internet-based procurement systems. Haas School of Business, University of California, Berkeley.
- [30] Strauss, A., Corbin, J. (1990). *Basics of qualitative research: Grounded theory procedures and techniques*. Thousand Oaks, CA: Sage Publications.
- [31] Wigand, R. T. (1997). Electronic commerce: Definition, theory, and context. *The Information Society*, 13(1), 43-54.
- [32] Wigand, R. T., Picot, A., & Reichwald, R. (1997). *Information, organization and management: Expanding markets and corporate boundaries*. Chichester, England: Wiley.
- [33] Yin, R. K. (1994). *Case study research: Design and methods* (2<sup>nd</sup> ed.). Thousand Oaks, CA: Sage.
- [34] Zenz, G., Thompson, G. H. (1994). *Purchasing and the management of materials* (7<sup>th</sup> ed.). New York, NY: Wiley and Sons.

# **Integrate the Information Technology with Supply Chain Management: A Trend of the Electronic Business in the New Century**

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## **Abstract**

In the new century, the concept of e-business (EB) has to be redefined. It covers more than e-commerce (EC) which simply handles with electronic ordering and/or on-line payment. EB covers all the managerial and operational functions of a business. So the concept of EB is to be more extensive. More and more people and business firms have recognized the fact that the application of Internet will cover both the outward functions (such as marketing, supplying, etc.) and the inward ones (such as manufacturing, R&D, etc.), go from the surface layers to the deeper layers, and arrive at the core of a firm's business and the center of the social economy. From the point of view of a business firm, more realistic EB refers to replacement of the physical activities with electronic processes and to establish new cooperative relations with the suppliers and customers, and among all internal sections of the firm. It can be shown from an investigation and the author's observations that the trend of EB is to integrate the information technology with the supply chain.

Once business firms have completed the ERP (enterprise resources planning) or other internal integrated information systems, the business firm could develop CRM (customer relation management) or SCM (supply chain management) and so on, to get an external optimization with the internal optimal process. So EB will come true when the bases are ready and sound.

By establishing communications between the upstream suppliers and the downstream cooperators, a business firm should extend its integrated information system and its operational conformity to the whole marketing management and to the whole supply chain.

In years, the downstream links of a supply chain (B to C) may exist in various forms for that the customers have their individualized needs. But among the upstream links of a supply chain (B to B), the traditional business modes among business firms will certainly be replaced by EB.

All the business firms have to face such a fact that from the basic application of Internet to the real-time business on Internet, there is a long way to go. At present, all business firms must face a complicated environment. Starting with the analysis of the environment of EB, this

paper discusses EB's trend and its influence on the business development, and brings forward that modern EB requires the participation of the suppliers, enterprise employees, cooperate partners, government and service institutes altogether.

## **1. Introduction**

Since most people recognized that e-business didn't mean the economy of web site, enterprises have begun to integrate their primary elements, such as products' R&D, manufacture, and marketing, with Internet. This trend has come into being since 2000 and assumed the following characteristics:

1. EB got developed with traditional enterprises as its core and the pattern of B to B as its mainstream. Recent studies by technology consulting groups show that more than one fourth of all B2B purchases will be transacted on the Internet by 2004—a dollar volume 10 times that of Internet consumer purchases[1]. International Date Corporation estimated that the total market turnover of the Internet in the whole world will exceed 425 billion dollars in 2002, more than 75% of which comes from B to B transactions.[2] Gartner Group further forecasted that in 2004 the volume of trade of B to B in the US will be more than 10 times of that of B to C at least.

2. EB is widely distributed not only into newly developed IT business but into traditional manufacturing industries and other service lines, such as circulation, securities and travel as well.

3. EB has got applied to a high degree. Many businesses have begun to make use of ERP, CRM and SCM, or even begun to conduct business integration both inside and outside the enterprise and established virtual firms.

In China, EB has experienced three stages or phases: the first phase (1997-1998): focused on IT manufacture and media; the second phase (1999-2000): focused on EB internet service; the third phase (2000-now): focused on traditional industries. In the third phase, enterprises are assuming the principle part of "e-transfer".

Such transformation is due to that (1) the consumption habits of consumers cause that it is impossible to expand B to C business in a large scale; (2)

commercial tension forced businesses to cooperate with their suppliers and clients more directly, and to make quicker response to any change. American Gartner Cooperation has predicted that any enterprise that still maintains the old style of mass production and keeps the control to marketing channels will become much less competitive in 2005. [3] The press originates from the below ten:

Table 1. The top ten business press enterprises face

More rapid commercialization of products	Relation-based competition (based on the quality of customer relationship, for instance)
Pressure from profits	Temporal-based competition (based on cycle of order, for example)
Increment of marketing channels	Special customers' requirements
More rapid launch of products	Globalized market
Web business requirements	Outsourcing relationship

SCM includes the optimizing of products, fund, and information transition between upstream suppliers and downstream cooperators. Therefore, it is a management of optimizing cost. On the other hand, the flow of various resources through the supply chains is an increment process. Hence, supply chains management can also be called incremental chain management.

By Internet, Extranet and Intranet, IT united all the business including upstream and downstream into supply chains of the whole manufacturing system, and formed a dynamic, virtual and global net of supply chains by combining with supply chains of other business and manufacture. Thus, purchasing cost and logistics activity cost are reduced, and every process of the whole net of supply chain are optimized. To the most important, enterprises' response to market and ultimate customers' requirements is made quicker, and the market competition of a business firm is promoted.

Supply chain management based on IT is an open

management pattern. Therefore, it is easier to achieve more personalized products and service with less production cost and quicker response.

As far as China is concerned, to achieve the more normative market environment and the more lucid information, IT-based SCM is a favorable choice for various enterprises involved in cooperation, which will make all enterprises, whether big or small, definitely benefit.

## 2. The Role of Information Technology (IT) in SCM

Enterprises' information technology includes three basic elements: Internet; Extranet and Intranet [4], which will make SCM adapt to e-business

Comparing with other communication means, Internet is the most resourceful and the cheapest. This facilitates enterprises to collocate their supply chains with lower cost within the whole world.

Extranets are dynamic wide area networks that link a company's employees, suppliers, customers and other key business partners in an electronic online environment for business communication. In manufacturing, setting up an Extranet linking business partners directly allows the handling of purchase order, receiving, invoicing to be done electronically over a secured network. The Extranet is a powerful form of infrastructure required for sophisticated SCM software that allows business partners to benefit from better response time, removal of non-value added inventories and reduction of overall inventory level in the chain by managing the information flow among business partners.

The Intranet allows the internal manufacturing operations to run smoothly and coherently by managing and providing information in a real-time manner to enhance resources planning process. Dispersed applications are linked together through client-server architecture [5].

Fig.1 illustrated how IT is permeated into supply chains and get used inside an enterprise and among enterprises.

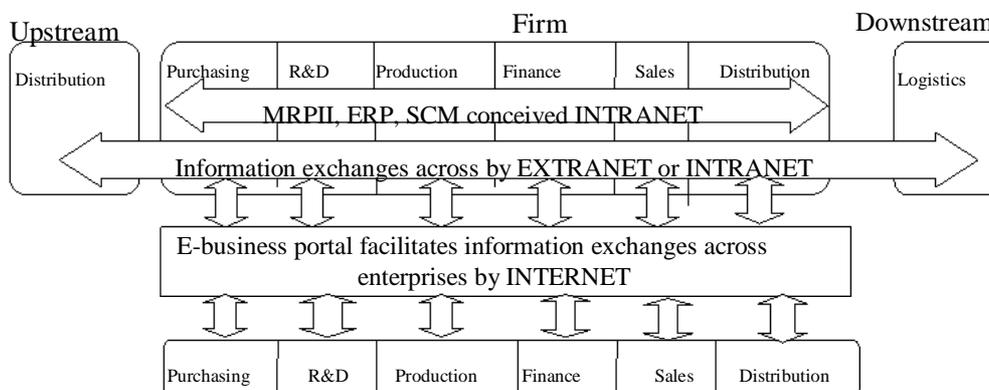


Fig.1. IT permeating into supply chain

Among the three streams in supply chains (that of material, information, and case), information stream is the most difficult to control. Information distortion is magnified gradually as it transmits from downstream to upstream of supply chains. This is so called 'the bullwhip effect'. [6] That is, orders given to upstream manufactures and supplier will fluctuate severely when there is only a tiny change in customer's requirements. IT improved SCM from three aspects.

1. Owing to IT, information transition and share among business partners within supply chains are changed from a linear structure to a network structure. This realized the direct relation between any two knots on the network and prevented information distortion caused by multi-layer prediction in the hierarchy structure. [7]

2. EDI provided criteria for global e-business. [8]

3. It is helpful to know the market instantly, and met ultimate personalized requirements.

As a kind of modern business management strategy, SCM owns a set of integrated strategic and tactical thinking, ECR, JIT, for instance. But only with the support of IT can the advantage of supply chains be fully taken.

### 3. Why the SCM Based on the IT will be the Trend of E-Business?

#### 3.1 Transformation of internal production organization patterns

In order to realize economies of scale, traditional industries usually adopt vertical solution production organization pattern. That is, the core enterprise united its raw-material suppliers into a cooperation organization by internal construction, merge and acquisition. This organization pattern confronted with three severe defects in 1990s when global economic environment changed a lot: (1) bulky business organizations couldn't make quick response to the complicated and ever-changing market requirements; (2) limited resource consumption in diverse field made it difficult to form conspicuous nuclear advantage; (3) the frequent economic fluctuation made it difficult for a company to receive the risk of investment and construction cycle resulted from internal construction, merge and acquisition. So the production organization patterns of many businesses have begun to transit from vertical solution to horizontal solution, a new production and management pattern.

Under the vertical solution pattern, supply chains within an enterprise are generally long. But for the management conformity within the enterprise, united information system and supply chain management system, it is comparatively easy to realize the best distribution of resources along the supply chains. And under the horizontal solution pattern, the supply chains to provide customers with integrated services are composed of many enterprises. Their connection doesn't take the form of 'chain' purely, but that of a complicated 'supply network' (virtual enterprises). As the interests conflicts among enterprises are prone to lead to the delayed transit and

distortion of information, the SCM becomes even more complicated. In this case, enterprises on the 'supply network' enter into a dynamic alliance or interests community, in which each enterprise only need to pay its attention to its own comparative competitive advantage in the value incremental chain. The new management pattern is not only capable of greatly promoting each enterprise's nuclear competitive competence, but also making it possible to reduce the investment and risk each enterprise undertakes, for they are dynamically organized. Therefore, supply chain management under horizontal solution has increasingly assumed the focus of both academic and industrial world. And the emergence of Internet and EB provided means to solve those issues. [9]

#### 3.2 The information-sharing management of exterior uncertain demand

At the age of e-business, thoroughly changes take place on the relationship between producer and consumer, which can attribute to the emergence of new markets. At the electronic space time beyond the tradition physics space time, the different demands of the customer gained further satisfied, which bring about even more complex and levity requirements. At the same time, since all sort of recourses become virtualized at the EB terrace, producers, to a greater extent, possess the throughput which can satisfied the increasingly changeful demands. So the result is that the relationship between producers and customers change from the push phase in which producers push their products to customers via 4Ps(Product, Price, Place, Promotion) to the pull phase in which producers are pulled by customers via 4Cs(Consumer, Cost, Convenience, Communication)

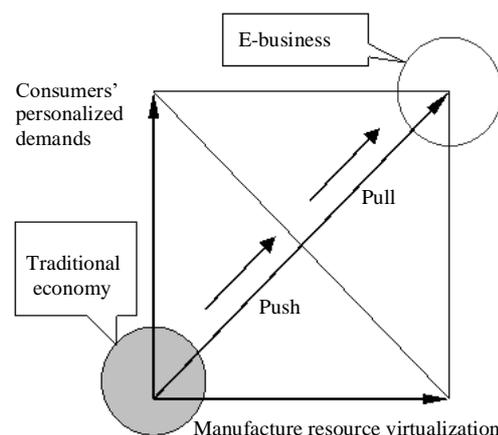


Fig.2 The change of relationship between producers and customers

Fig.2 shows the change. From the point of view of SCM, with the degree of produce recourses virtualization and the pull power of consumers enhancing, the headstream which supply power to the flow of logistics

and information changes from the producers to the consumers That's to say, at the traditional mode, the SCM is focused on how to make use of the producers' predominance in the production technique and management method. While at the age of e-business, it is centered on how to ensure the customers' driver status, how to make use of information by analyzing the uncertain demand, and how to create value by sharing the information on the whole supply chain.

#### 4. The E-Business Cases in China

Viewed from the fulfillment result, most enterprises that carried out e-business have get profits, such as Haier and Legend. Integrating the information technology with SCM in Chinese large business enterprises has become the main body EB's application.

##### 4.1 Haier Group

###### 4.1.1 Background

Haier Group is the biggest home appliances producer in China. Haier now produces a wide range of household electrical appliances in 86 categories and 13,000 specifications. Its products are exported to 160 countries. A total global sale of Haier in 2001 was 7.28 billion dollars. Haier's international promotion framework encompasses competitive globalize trading design, production, distribution and after-sales service networks. Haier now operates 18 design institutes, 10 industrial complexes (1 in USA, 1 in Pakistan, 8 in China), 58,800 sales agents and 11,976 after-sales services throughout the world.[10] Haier operation capital in one year has 12 billion dollars and average 33.4 million dollars a day. Haier receives 0.9 million order which involve 10,000 specifications around the world every mouth, and need to stock 0.26 million kinds of raw and processed materials. So if Haier did not carry out SCM and information technology management, it is difficult to maintain current operation, not to speak of development.

###### 4.1.2 The processes and the effects

1. Strategically adjusting the organizations is the basis of the realization of general information management.

Haier changes from former function management which junior was responsible for superior to the flow management which every department was responsible for markets. Haier's organization is also reformed from a pyramid pattern to a flat style, and converging every subsidiary's logistics, capital, information flow departments to headquarters. And it carries out purchase, physical distribution, storage and conveyance globally. All of these form the main procedure of operation of Haier.

Haier integrates its function management recurses to form 3R departments (R&D, HR, CR---customer recurses) which develop orders and form 3T departments (TCM, TPM, TQM) which ensure the

fulfillment of orders. 3T and 3R are function departments that had been registered as independently working service company.

Haier saves more than 13 million dollars every year from its interior recurses integration.

2. Carrying out the reconstruction of information SCM based on marketing chain

Haier e-business Company comes into existence in 2000, which carries out B to B for suppliers and B to C for customers. By e-business purchase and customization terraces, Haier establishes close relationships with suppliers and marketing terminals by Internet and thus strikes up dynamic business enterprise alliances. Haier's business process is shown in Fig.3

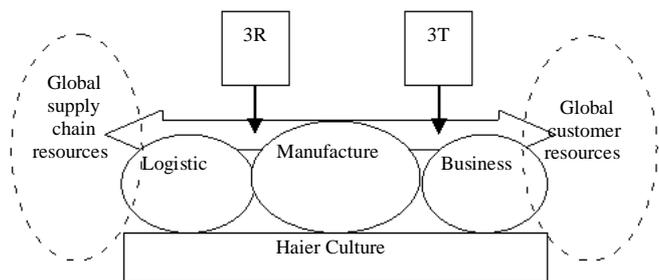


Fig.3 Haier's business process

On the basis of BPR, Haier's SCM has formed a closed loop system. Now, all of Haier's purchase order and 20% of the payment come from the Internet. The performance of inviting public bidding and competitions of price on the Internet makes the prices management more transparent.

The application of computer network cuts down the period of purchase from 10 days to 3 days and reduces the cost of SCM, the sluggish material by 73.8%, the area of warehouse by 50%, and the storage capital by 67%.

###### 3. Interior agile manufacturing

Haier's e-manufacturing adopts CAD and CAM to construct CIMS (Computer Integration Manufacture System). On the basis of DSS (decision support system), ERP, JIT, agile manufacturing system, and concurrent engineering which can correspond with the design and manufacture by network, Haier realized the change from volume-product to mass custom-made.

##### 4.2 Legend Group

###### 4.2.1 Success of China Legend Group

Legend Group is the largest computer manufacturer in China.

The successful establishment of EB terrace makes the producing, marketing and purchasing related each other, and saves capital 0.25 billion dollars only from shortening the stock cycle.[11] In 2000, Legend made profit of 0.1 billion dollars after the establishment of basic EB terrace.

Tables 2 and 3 are the aspects of its marketing and operation management.

Table 2. The aspects of marketing

Year	1998 (Before actualizing EB)	2000 (After actualizing EB)
Sale quantity (million sets)	0.791	2.618
Sale (billion dollars)	2.13	3.43
Market share in China (%)	10.7	30

Table 3. The aspects of operation management

Year	1995	2001
Stock cycle (days)	72	22
Turnover days of receivables	28	14

Legend only invested 3.63 million dollars in ERP and invested 18.2 million dollars to construct three EB terraces including date, process and decision-making.

#### 4.2.2 The developmental process of EB of China Legend group

Legend considers that the aim of B to B is to extend exchange. The integration of enterprises' interior and exterior recurses by ERP is the basis of B to B, and is the necessary guarantees of sustainable development of B to B.

Legend adheres to channel sale system and adopts B to B model from original telephone and fax to dynamic information issuance system. Now, Legend has realized the integration of B to B's former system with the ERP terrace, so the agents can learn the orders including the information such as the time of shipment, the warehouse of the consignment, the circumstance of goods on transportation, the railway and air parcel's indentures and conveyances. Its exchange volume from e-business broke through 1 billion dollars in 1999 and accounted for 50% of total exchange in 2001.

## 5. New Characters of IT and SCM

### 5.1 Shortened and virtualized supply chain

The essential characters of production in communication society are to shorten the intermediate link between manufacture and consuming and to create value by responding to targets quickly and directly. The digital network provides a realistic and reliable foundation for cutting the unnecessary inter-link processes. The supply chain on EB is no longer a complex multi-level network, which is shortened and virtualized. That is, for business reasons, a manufacturer and a supplier can form strategic fellowship, but once the exchanges finished, their fellowship ended. The exchanging costs are reduced and the products become individualized.

### 5.2 The flat and netlike inner-organization

On EB, the information communion is no longer subject to space-time restrictions. The communications among various departments within an enterprise, such as marketing, designing, manufacture and stocking become smooth. The management scope of the departments becomes blurred and the management span was extended. Therefore, the corporation groups' management system transforms from the multilayer pyramid style to an information-based flat and netlike style which takes the projects as longitude and takes the manufacture flat roof, the marketing flat roof, the administration flat roof as the latitude to administrate. As a result, the administration cost is descended and the market reaction to the customer needs is accelerated.

### 5.3 Information can create new value

In supply chain of EB, the information does no longer perform the assistant support function, but bring new value by aggregating, organizing, selecting, composing and distributing. The enterprises can utilize the information to enhance value on three phases: the first phase is visible management; the second phase is reflection ability; the third phase is constructing new customer relationship by IT. At the age of industrial economy, the value increment is manifested by substance increment, but at the age of information, it becomes more and more dependent on the information and knowledge.

### 5.4 The weakened predominance of economies of scale

In supply chain of new EB with agility manufacturing, economies of scale will not possess great predominance than ever. The extremely important thing is to give prominence to core competencies in the supply chain and the value chain. Together with the transparent information and opening supply chain connection, there are more opportunities to small and medium enterprises (SMEs).

Many of the e-business portals are developed by large corporations for free participation, there lie the opportunities for SMEs to access part of varieties of trading communities. For example the Legend Group has 2000 agents around China and the Haier Group has 1000 agents around the world. Fig.4 shows the opportunities of SMEs in participating in e-business portals.

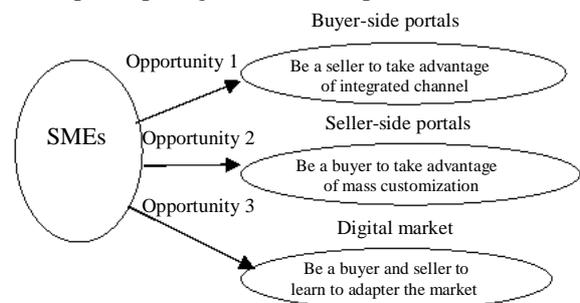


Fig.4 Opportunities for SMEs participating in EB

## 6. Conclusion

EB is changing the world economy drastically, and this alteration is more rapid than any other economy transform in history. Many experts have assumed that e-business in emerging markets will evolve along the same lines as it has in the US, North America, and to a great extent, in Western Europe. This assumption fails to take into account the differences that exist between the economic infrastructures of emerging markets and those of the developed markets of the West. China's economic infrastructure, which like the infrastructures of most emerging markets is much less highly developed than the industrial West's, will influence the development of e-business in China [12].

The network revolution and the EB revolution caused by network revolution are global. How to find a new development path that makes China enterprises linking with the world experiences is an urgent task to be solved.

As this paper has discussed, the construction of China e-business should start with the building of infrastructure facilities altogether with the participation of enterprises as the cells of economy. The timorously development of SCM based on the information technology is the preparatory work for massive introduction of EB. All the business firms have to face such a fact: from the basic application of Internet to the real-time business on Internet there is a long way to go. On the current stage, all business firms must face a complicated environment. Starting with the analysis of the environment of EB, this paper discusses EB's trend and its influence on the business development, and brings forward that modern EB requires the participation of the suppliers, enterprise employees, cooperate partners, government and service institutes altogether.

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## References

- [ 1 ]William Kuechler Jr., Vijay K. Vaishnavi, David Kuechler, Supporting optimization of business-to-business e-commerce relationships, *Decision Support Systems* 31 2001 363–377
- [ 2 ]Syed Mahbubur Rahman, Mahesh S.Rasinghani *Electronic commerce : Opportunity and Challenges* Idea Group Publishing, Hua xia Publishing house 2001
- [ 3 ]Karen Peterson, Eric Purchase, (Gartner Group strategy report)e-business Philosophy, logistics and material handling,(4)2001,27-28
- [ 4 ]Michael F.S. Chan, Walter W.C. Chung A framework to develop an enterprise information portal for contract manufacturing, *Int. J. Production Economics* 75 (2002) 113–126
- [5]T.H. Davenport, Putting enterprise into the enterprise system, *Harvard Business Review* 76 (4) (1998) 121–133.
- [6]Lee H L, Padmanabham V, Whang S, Information distortion in a supply chain: the bullwhip effect, *Management Science*, 1997,43(4):546-558
- [7]Wang juxiang, Hu zongwu, Wang anling, the supply chain management base on e-business, *Manufacturing Automatization*,22(10),2000,27-29
- [ 8 ]Sunil Chopra, Peter Meindl, *Supply Chain Management: Strategy, Planning and Operation*, Prince Hall Publishing,2001,391-393
- [9]Lan Boxiong, Zheng Xiaona, Xuxin, The Supply Chain Management in e-business age, *Chinese Journal of Management Science*,8(3)2000 1-2
- [10]Zhang ruiming, Haier : Carrying out BRP based on market chain, setting up enterprise total information management *China daily post and telecom*, 2002-01-03
- [ 11 ]Caoli From Legend's B2B forecasts China e-business future, *economy and trade guide magazine*, 2002, 4, 4-5
- [12]George T. Haley, E-commerce in China Changing business as we know it, *Industrial Marketing Management*, (31) 2002, 119–124

# Some Models for Understanding the Incentives for Supply Chain Collaboration

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## Abstract

The need for information sharing has been increasing as a consequence of the globalization of production and sales, and the advancement of enabling technologies. Yet, beyond resolving the technical issues associated with information sharing and joint decision making, a greater challenge is for the supply chain partners to understand the “lost value” due to uncoordinated decision-making, and more importantly, to determine how the recovered value will be shared among the participating stakeholders. This paper presents some models for understanding the incentives for supply chain collaboration, and describes the enabling technologies for collaborative demand planning and replenishment.

## 1. Introduction

Synchronizing the supply chain from raw materials to the consumer offers the greatest opportunity to improve profitability and provide greater value to the consumer. It is quickly becoming the standard for competition.

### 1.1 The Bullwhip Effect

A well-balanced and well-practiced relay team is more competitive when each runner knows how to be positioned for the hand-off. The relationships are the strongest between players who directly pass the baton, but the entire team needs to make a coordinated effort to win the race [4]. Unfortunately, stakeholders along the supply chain have different and frequently conflicting objectives. Accordingly, the stakeholders often operated independently, resulting in a phenomenon called the bullwhip effect on demand and supply [14], [15], [3], [6]. As a result of the bullwhip effect, orders to the supplier tend to have larger variance than sales to the buyer (i.e. demand distortion), and the distortion propagates upstream in an amplified form.

### 1.2 Supply Chain Collaboration

Supply chain collaboration requires industry-wide process and data standards for information exchange. It requires a reliable and secure data exchange medium to facilitate collaborative decision making. Electronic data interchange (EDI) was an initial attempt towards facilitating communication between trading partners. With the advent of the Internet, business documents could now be quickly and securely exchanged. Organizations such as RosettaNet have developed

standards and guidelines for automatic system-to-system exchange of business information and transaction [7].

### 1.3 Incentives for Supply Chain Collaboration

Enabling collaborative supply chain goes beyond resolving the technical issues associated with information sharing and joint decision making. Perhaps a bigger challenge is for the supply chain partners to understand the “lost value” due to uncoordinated decision-making, and more importantly, to determine how the recovered value will be shared among the participating stakeholders.

For example, in collaborative forecasting, if there is no incentive to bind the customers to their forecasts, the customers may be motivated to over-forecast to raise the likelihood that the supplier will have sufficient stock should the customers require more. On the supplier side, if information provided to the customers about the supplier’s allocation is not binding, if the supplier’s situation changes, it could change the allocation at the last minute.

This paper presents some models for understanding the relationships between demand distortion and safety-stock level, and describes the enabling technologies for collaborative demand planning and replenishment.

## 2. B2B Means “Belly-To-Belly”

The need for information sharing has been increasing as a consequence of the globalization of production and sales, and the advancement of enabling technologies. Improving supply chain efficiencies means the companies should direct their focus outside of the four walls of their enterprises. E-business technology is beginning to restructure the ways businesses conduct business. Yet, no matter how much has changed in the new economy, business is still a function of the same reciprocal, collaborative process of decision-making that defined commerce centuries ago and still applies to today's multinational trade. Supply chain collaboration is not, and will never be conducted within the confines of the impersonal, anonymous environments of computer workstations. As Palmer aptly puts it, B2B may as well stand for “belly-to-belly” [11]!

### 2.1 Inter-Organizational Information Sharing

Collaborative demand planning begins with information sharing. Information sharing can occur within an organization (intra-organizational) as well as across organizations (inter-organizational).

A widely cited benefit of information sharing is that it can dampen the bullwhip phenomenon. The bullwhip effect often results in excess cost, such as inventory cost, transportation cost or excess raw materials cost due to unplanned and unbalanced production. Using simulation and analytical research, [8] shows that sharing “sell-through” data and inventory information from downstream stakeholder might reduce the bullwhip effect on upstream stakeholders.

Inter-organizational information sharing is at the core of today's most important business strategies, including Web enablement, supply chain management (SCM), customer relationship management (CRM), multichannel and mobile computing, and self-service applications. Inter-organizational information sharing employs collaboration techniques to create a multi-echelon supply chain involving the focal organization and additional suppliers and customers. At present, the most popular collaboration models include the Collaborative Planning, Forecasting and Replenishment (CPFR) model [5], and RosettaNet-based software solutions like WebLogic [2].

CPFR is a set of guidelines supported and published by the Voluntary Inter-industry Commerce Standards (VICS) Association. Trading partners share their plans for future events, and then use an exception-based process to deal with changes or deviations from plans. By working on issues before they occur, both partners have time to react.

A supplier can build inventory well in advance of receiving a promotional order and carry less safety stock at other times. A retailer can alter the product mix to reduce the impact of supply problems.

RosettaNet is an independent, self-funded, non-profit consortium founded in 1998. The consortium is dedicated to the development and deployment of standard electronic commerce interfaces to align the processes between IT supply chain partners on a global basis.

As of April 1999, the RosettaNet Managing Board consists of 34 CEOs, CIOs, and executives representing global members of the IT supply chain, including initial board member companies: American Express, CHS Electronics, Cisco Systems, CompUSA, Compaq, Computacenter, Deutsche Financial Services, EDS, Federal Express, GE Information Services, GSA, Hewlett-Packard Co., IBM, Ingram Micro Inc., Insight, Intel, Microage, Microsoft, Netscape, NEC Technologies, Oracle, pcOrder, SAP AG, Tech Data, Toshiba Information Systems and United Parcel Service (<http://xml.coverpages.org/rosettaNet.html>).

## 2.2 Intra-Organizational Information Sharing

Intra-organizational information sharing occurs at the data level and at the business-process level. These two levels of information sharing have been widely studied by SCOR [12] and RosettaNet ([www.rosettanet.org](http://www.rosettanet.org)). Solutions such as RosettaNet rely heavily on the definition of EDI-like standards for the exchange of data, process knowledge, messages, etc. [2].

Intra-organizational information sharing means creating or modifying the interactions among semi-autonomous but related application systems, encompassing purchased packages, legacy applications and new Web services. This is generally realized through ERP or middleware serving as an information backbone to transact and convert data among disparate systems.

Enterprise Application Integration (EAI) links together diverse systems and applications across the enterprise, allowing the organization to keep pace with and respond to market changes [9]. An enterprise resource planning (ERP) system, on the other hand, provides an integrated transaction processing fabric for an organization, which enhances organizational performance by reducing information inconsistency and by improving transaction-processing efficiency.

## 3. Incentives For Collaboration

In [13], Sharafali and Co showed that significant savings in inventory-related costs could be achieved if the buyer and the seller cooperate. In analyzing the buyers' and the sellers' replenishment decisions, the authors pointed out that only the supplier benefits from such cooperation. In order to motivate the buyer to cooperate, the authors considered some cooperative strategies. These include the analysis of the impact of (1) price changes, (2) discount policies, and (3) partial deliveries. The authors showed that the partial deliveries strategy is preferable. This is in tune with the benefits cited in the literature as a result of JIT-like relationship between the two parties concerned.

Due to the bullwhip effect, suppliers often have to deal with a demand patterns that are perceived to be erratic and cyclical. The variability of demand increases in moving up the supply chain from consumer to retailers to distribution center to central warehouse to factory. This section provides some models for understanding the advantages of cooperation between the supplier and the buyer: collaborative demand planning.

### 3.1 Optimal Safety-Stock

Uncertainties in lead time and demand exert considerable influence on the stability and credibility of inventory control systems. There are various strategies for coping with the many sources of uncertainties. Murthy and Ma [10] provide an excellent review along with the possible research directions for coping with uncertainties in Material requirements planning systems.

Let  $Y_t$  = replenishment quantity at period  $t$ , for  $t = 1, 2, \dots, n$ , where  $n$  is the length of the planning horizon. The current period is  $t = 1$ . If the lead time =  $L$ , then  $Y_t$ , for  $t = 1-L, 2-L, \dots, 0$ , represent the on-order quantities that are expected to arrive in periods  $1, 2, \dots, L-1, L$  respectively.

Let  $I_{t+L-1}$  = beginning inventory at period  $t+L$ . If the forecasted demand for period  $t+L$  is  $\mu_{t+L}$ , the replenishment quantity made  $L$  periods ago should at least be equal to  $\mu_{t+L} - I_{t+L-1}$  (Otherwise, there would be a

shortage). Supposed the desired safety stock for period  $t+L$  is  $s_{t+L}$ , then  $Y_t = [\mu_{t+L} + (s_{t+L} - I_{t+L})]^+$ . Let  $s_{t+L} = \beta_{t+L}\mu_{t+L}$ , i.e., the safety stock is a fraction of the forecasted demand. Then,

$Y_t = [(1 + \beta_{t+L})\mu_{t+L} - I_{t+L}]^+$ . In the literature, the  $\beta_{t+L}$  is often referred to as the overplanning factor.

The actual demand  $D_t$  is stochastic and non-stationary. Let  $G_t =$  demand distribution is with mean  $\mu_t$  and standard deviation  $\sigma_t$ . Assume the demand sequence  $\{D_t, t = 1, 2, \dots\}$  to be mutually independent. We assume that the forecast for each period  $t$  is unbiased and is equal to  $\mu_t$ . Since demand is non-stationary, the optimal production ordering quantities vary over the planning horizon. In practice, under such an environment, decisions are usually made on a rolling horizon basis. That is, each time a period has passed, it is dropped from the planning horizon, and the forecast demand for a new period is added at the end of the forecast window.

Suppose demand not met are backordered at a cost of  $p$  \$/unit; and the unit inventory holding cost is  $h$  \$/unit. If the ending inventory in period  $t$  is  $I_t$ , the total inventory cost for period  $t$  is  $h[I_t]^+ - p[I_t]^-$ , where  $[I_t]^+ = \max(0, I_t)$  and  $[I_t]^- = -\min(0, I_t)$ . The optimal replenishment problem is to determine  $Y_t$ , for  $t = 1, 2, \dots, n$ , such that:

$$\text{Min}_{\beta_{L+1}, \beta_{L+2}, \dots, \beta_{L+n}} E[TC] = \sum_{t=1}^n [hE[I_{t+L}^+] - pE[I_{t+L}^-]] \quad (1)$$

Subject to:

$$\begin{aligned} I_{t+L} &= I_{t+L-1} + Y_t - D_{t+L} \\ Y_t &= [(1 + \beta_{t+L})\mu_{t+L} - I_{t+L-1}]^+ \\ \beta_{t+L} &\geq 0, \text{ for } t = 1, 2, \dots, n. \end{aligned} \quad (2)$$

The objective function (1) is convex (see [1]). Solving

$$\frac{\partial}{\partial \beta_{t+L}} E[TC] = 0 \quad \text{leads to} \quad G_{t+L}((1 + \beta_{t+L})\mu_{t+L}) = \frac{p}{p+h}, \quad t = 1, 2, \dots, n \quad (3)$$

Note that (3) is true for any lead-time  $L$ , for simplicity we assume that  $L = 0$ . As we have a rolling schedule, we plan for the replenishment quantity for the current period, i.e., we consider  $t = 1$ . Equation (3) then

$$\text{becomes: } \beta_1 = \frac{1}{\mu_1} G_1^{-1} \left( \frac{p}{h+p} \right) - 1. \quad (4)$$

We note that the successive overplanning factors are constant if the sequence of demands are independent and identically distributed (i.i.d.).

### 3.2 Forecast Errors and Safety-Stock

Suppose  $D_n$  is exponentially distributed,

then  $G_n(x) = 1 - e^{-\mu_n^{-1}x}$ ,  $x > 0$

Then  $[1 - e^{-(1+\beta_1)\mu_1^{-1}}] = \frac{p}{h+p}$ , or  $e^{-(1+\beta_1)\mu_1^{-1}} = \frac{h}{h+p}$ .

Hence,  $\beta_1 = -\mu_1 \ln \frac{h}{h+p} - 1$

or  $\beta_1 \mu_1 = \mu_1^2 \ln \frac{h+p}{h} - \mu_1$ . The optimal safety stock

is a quadratic function of the sales forecast! Clearly, this can be seen as the worst-case scenario. If the demand distribution is exponentially distributed, the level of uncertainty as measured by the variance is as large as the forecast itself (the mean).

Suppose  $D_n$  is uniformly distributed over  $(a_n, b_n)$ , then

$$G_n(x) = \begin{cases} \frac{x - a_n}{b_n - a_n}, & a_n < x < b_n \\ 1, & x \geq b_n \\ 0, & \text{otherwise} \end{cases}$$

It can be shown that the optimal safety stock  $\beta_1 \mu_1 =$

$$\frac{(p-h)(b_1 - a_1)}{(p+h)(b_1 + a_1)} \mu_1$$

Apparently  $0 < \beta_1 < 1$ . This guarantees that the safety-stock level will never exceed 100% of forecasts.

Moreover, if the forecasts are unbiased, then  $(b_1 + a_1)/2 =$

$\mu_1$ , the optimal safety stock is  $2 \cdot \frac{(p-h)}{(p+h)} \cdot (b_1 - a_1)$ ,

i.e., the optimal safety-stock level is directly proportional to the forecast error  $=K \cdot (b_1 - a_1)$ . It is noteworthy that as inventory-holding cost approaches backordering cost, the need for safety stock diminishes.

## References

- [1] Allen, S.G. (1958), Redistribution of total stock over several user locations, Naval Research Logistics Quarterly, 5, 337-346.
- [2] Ball, Michael O., Meng Ma, Louiqa Raschid and Zhengying Zhao (2002), "Supply Chain Infrastructures: System Integration and Information Sharing," Special Section on Data Management Issues in Electronic Commerce, Association for Computing Machinery (ACM) Special Interest Group on Management of Data (SIGMOD), Volume 31, No. 1, March 2002.  
<http://www.acm.org/sigmod/record/issues/0203/SPE-CIAL/10.ball.pdf>
- [3] Chen, F. and R. Samroengraja (2000), "The Stationary Beer Game," Production and Operations Management (a special issue on teaching supply chain management) 9, No. 1, 19-30.
- [4] Cooper, M. C., & Ellram, L. M. (1993). "Characteristics of supply Chain management and the implications for purchasing and Logistics strategy," The International Journal of Logistics Management, 4, 13-24.
- [5] CPFR, (2001), Collaborative Planning, Forecasting and Replenishment. Voluntary Inter-industry Commerce Standards (VICS) Association.  
[www.cpfr.org](http://www.cpfr.org).
- [6] Jacobs, R. (2000), "Playing the Beer Distribution Game over the Internet," Production and Operations Management (a special issue on teaching supply chain management) 9, No. 1, 31-39.
- [7] Kak, R. and Sotero, D., "Implementing RosettaNet E-Business Standards for Greater Supply Chain Collaboration and Efficiency," RosettaNet 2002,  
<http://www.rosettanet.org/>.
- [8] Lee, H., Padmanabhan, V. & S. Shang, S. (1997), "Information Distortion in a Supply Chain: the Bullwhip Effect," Management Science, 43(4):548-558.
- [9] Linthicum, D. (2000), Enterprise Application Integration, Addison-Wesley.
- [10] Murthy, D.N.P. and Ma, L. (1991), MRP with uncertainty: a review and some extensions, International Journal of Production Economics, 25, 51-64.
- [11] Palmer, N. (2002), "The Truth about B2B," EAI Journal,  
<http://www.eaijournal.com/ArticlePrint.asp?ArticleID=122>
- [12] SCOR (1999), Supply-Chain Operations Reference model (SCOR), Plan / Source / Make / Deliver, Version 3.1. Supply-Chain Council, Pittsburgh (PA).  
<http://www.supply-chain.org>. 1999.
- [13] Sharafali, Moosa and Co, H., "Some Models for Understanding the Cooperation between the Supplier and the Buyer," International Journal of Production Research, Vol. 38, No. 15, 2000, pp. 3425-3449.
- [14] Sterman, J.D. (1989), "Modeling Managerial Behavior: Misperceptions of Feedback in a Dynamic Decision Making Experiment" Management Science 35 pp.321-339.
- [15] Sterman, J.D. "Teaching Takes Off: Flight Simulators for Management Education" OR/MS Today October 1992 pp.40-44.

## A Multiple Criteria Decision Support Web-Based System for Facilities Management

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### Abstract

An analysis of multiple criteria decision support systems and facilities management Web-based automation applications that were developed by researchers from various countries assisted the authors to create one of their own Multiple Criteria Decision Support Web-Based System for Facilities Management (DSS-FM). DSS-FM differs from others in its use of new multiple criteria analysis methods as were developed by the authors. The database of a facilities management was developed and provides a comprehensive assessment of alternative versions from the economic, technical, technological, infrastructure, qualitative, technological, legislative and other perspectives. Based on the above complex databases, the developed Multiple Criteria Decision Support Web-Based System for Facilities Management enables the user to analyze alternatives quantitatively and conceptually. Applying the DSS-FM may increase the efficiency of calculators, analyzers, software, neural networks, expert and decision support systems and e-commerce.

One of the major problems in e-business is to find what you want. The number of alternative products and services on the Internet are in the thousands. How can customers find the rational products and services on the Internet? Once product or service information is found, the customer usually wants to compare alternatives.

The major players in facilities management Web sites can find calculators, analyzers, software, neural networks, expert and decision support systems and e-commerce, etc. According to B.K. Forbes [1] [2], the top seven facilities management automation application areas follows: real property and lease management, strategic master planning, space management, furniture and equipment management,

telecommunications and cable management and building operations management.

A calculator is software application that is used for completing mathematical calculations. Facilities management Web sites sometimes contain calculators: CRESA Space Calculator [7] (calculates office space needs), Comfort calculator [8] (analyzes thermal comfort and estimates the optimal temperature), etc.

Web sites might also contain various purpose analyzers [9, etc.] that help customers to analyze various facilities management situations.

Information about facilities management software can be found on the following facilities management Web sites: ARCHIBUS/FM [10], FM Systems [11], etc. The above facilities management software offers various modules and tools: lease management, move management, strategic space planning, maintenance management, accounting charge-back, communication/cable management and personnel management.

Expert systems [12, etc.] today generally serve to relieve a 'human' professional of some of the difficult but clearly formulated tasks.

The major players in facilities management can use various purpose decision support systems [13, etc.]. The decision support system (DSS) provides a framework through which decision-makers can obtain the necessary assistance for decisions through an easy-to-use menu or command system.

The above calculators, analyzers, software, neural networks, decision support and expert systems, e-commerce, etc, are not connected. Therefore, in the future the above FM automation solutions to some extent must be integrated.

Based on the analysis of the multiple criteria decision support systems and facilities management Web-based automation applications and in order to determine the most efficient versions of real estate and facilities

management, a Multiple Criteria Real Estate E-Commerce System was developed. The Multiple Criteria Decision Support Web-Based System for Facilities Management (DSS-FM) consisting of a database, database management system, model-base, model-base management system and user interface is a part of the Multiple Criteria Real Estate E-Commerce system and was developed by the authors of this research. A short description of the DSS-FM follows.

Facilities management involves a number of interested parties who pursue various goals and have different potentialities, educational levels and experiences. This leads to various approaches of the above parties to decision-making in this field. In order to do a full analysis of the available alternatives and to obtain an efficient compromise solution, it is often necessary to analyse economic, qualitative, legal, social, technical, technological, space and other type of information. This information should be provided in a user-oriented way.

The presentation of information needed for decision-making in the DSS-FM may be in a conceptual form (i.e. digital/numerical, textual, graphical, diagrams, graphs and drawing, etc), photographic, sound, video and quantitative forms.

The presentation of quantitative information involves criteria systems and subsystems, units of measurement, values and initial weights that fully define the provided variants. Conceptual information means a conceptual description of the alternative solutions, the criteria and ways of determining their values and the weights, etc.

In this way, the DSS-FM enables the decision-maker to receive various conceptual and quantitative information on facilities management from a database and a model-base allowing him/her to analyse the above factors and to form an efficient solution.

The analysis of database structures in decision support systems according to the type of problem solved reveals their various utilities. There are three basic types of database structures: hierarchical, network and relational. DSS-FM has a relational database structure where the information is stored in the form of tables. These tables contain quantitative and conceptual information. Each table is given a name and is saved in the computer's external memory as a separate file. Logically linked parts of the table form a relational model.

To design the structure of a database and perform its completion, storage, editing, navigation, searching and browsing etc. a database management system was used in this research.

The user seeking for an efficient facilities management solution should provide, in the tables assessing facilities management solutions, the exact information about alternatives under consideration as to the client's financial situation. It should be noted that various users making a multiple criteria analysis of the same alternatives often get diverse results. This may be due to the diversity of the overall aims and financial positions of the users. Therefore, the initial data provided by various users for calculating the facilities management project differ and consequently lead to various final results.

The character of the objective's choice for the most efficient variant is largely dependent on all available information. It should also be noted that the quantitative information is objective. The actual facilities management services have real costs. The values of the qualitative criteria are usually rather subjective though the application of an expert's methods contributes to their objectivity.

The interested parties have their specific needs and financial situation. Therefore, every time when the party uses the DSS-FM they may make corrections to the database according to their aims and their financial situation.

The efficiency of a facilities management variant is often determined by taking into account many factors. These factors include an account of the economic, aesthetic, technical, technological, management, space, comfort, legal, social and other factors. The model-base of a decision support system should include models that enable a decision-maker to do a comprehensive analysis of the available variants and to make a proper choice. The following models of a model-base aim at performing the functions of: a model for the establishment of the criteria weights; a model for multiple criteria analysis and for setting the priorities; a model for the determination of a project's utility degree; a model for the determination of a project's market value.

According to the user's needs, various models may be provided by a model management system. When a certain model (i.e. search for facilities management alternatives) is used the results obtained become the initial data for some other models (i.e. a model for multiple criteria analysis and setting the priorities). The results of the latter, in turn, may be taken as the initial data for some other models.

The management system of the model base allows a person to modify the available models, eliminate those that are no longer needed and add some new models that are linked to the existing ones.

The following multiple criteria analysis methods and models as developed by the authors (Kaklauskas, A., Zavadskas E. [3] [4] [5] [6] are used by the DSS-FM in the analysis of the facilities management alternatives:

a new method and model of complex determination of the weight of the criteria taking into account their quantitative and qualitative characteristics was developed; a new method and model of multiple criteria complex proportional evaluation of projects enabling the user to obtain a reduced criterion determining the complex (overall) efficiency of the project was suggested.

In order to find what price will make a valued project competitive on the market a method and model for determining the utility degree and market value of projects based on the complex analysis of all their benefits and drawbacks was suggested; a new method and model of multiple criteria multi-variant design of a project's life cycle enabling the user to make computer-aided design of up to 100,000 alternative project versions was developed. Any project's life cycle variant obtained

in this way is based on quantitative and conceptual information.

Application of Multiple Criteria Decision Support Web-Based System for Facilities Management (DSS-FM) allows one to determine the strengths and weaknesses of each phase and its constituent parts. Calculations were made to find out by what degree one version is better than another and the reasons disclosed why it is namely so. Landmarks are set for an increase in the efficiency of facilities management versions. All this was done argumentatively, basing oneself on criteria under investigation and on their values and weights. This saved users' time considerably by allowing them to increase both the efficiency and quality of facilities management analysis.

Below is a list of typical facilities management problems that were solved by users: multiple criteria analysis of space management, administrative management, technical management and management of other services alternatives; analysis of complex facilities management alternatives; analysis of interested parties (competitors, suppliers, contractors, etc.); determination of efficient loans; analysis and selection of rational refurbishment versions (e.g. roof, walls, windows, etc.); multiple criteria analysis and determination of the market value of a real estate (e.g. residential houses, commercial, office, warehousing, manufacturing and agricultural buildings, etc.); analysis and selection of a rational market; determination of efficient investment versions, etc.

## Conclusions

Facilities management is an information business. Technological innovation mainly through changes in the availability of information and communication technology inclusive calculators, analysers, software, neural networks, decision support and expert systems, e-commerce that have been provided by a variety of new services developed by the facilities management sector. Most of all calculators, analysers, software, decision support and expert systems, neural networks seek to find out how to make the most economic facilities management decisions and most of all these decisions are intended only for economic objectives. Facilities management alternatives under evaluation have to be evaluated not only from the cost (design, construction, indirect expenses, operating and maintenance expenses, renovation costs, the interest paid on loan), but take into consideration qualitative, technical, technological, space and other characteristics as well. Therefore, applying multiple criteria analysis methods and decision support systems may increase the efficiency of facilities management calculators, analysers, software, neural networks, decision support and expert systems, e-commerce. Based on an analysis of multiple criteria decision support systems and facilities management Web-

based automation applications and in order to determine the most efficient versions of facilities management Multiple Criteria Decision Support Web-Based System for Facilities Management was developed by authors of paper. The related questions were analysed in this paper.

## References

- [1] B.K.Forbes, A.R.Forbes, J.M.Forbes, C.M.Zawadski (2000-1). Facilities Management Automation and Infrastructure Management. Facilities Engineering and management Handbook. Commercial, Industrial, and Institutional Buildings. McGraw-Hill.
- [2] B.K.Forbes, J.M.Forbes, R.E.Forbes, C.M.Zawadski (2000-1). The Role of E-Commerce and Business-to-Business Electronic Marketplaces in Facilities Management. Facilities Engineering and management Handbook. Commercial, Industrial, and Institutional Buildings. McGraw-Hill.
- [3] Kaklauskas, A. (1999) Multiple criteria decision support of building life cycle. Research report presented for habilitation. Technological sciences, civil engineering (02T), Vilnius Gediminas Technical University, Technika.
- [4] Kaklauskas, A., Lepkova, N. (2001), Facilities management object and multiple criteria analysis // Modern building materials, structures and techniques: abstracts of 7th international conference, held on May 16-18, 2001 Vilnius, Lithuania / VGTU. - Vilnius : Technika, p.170-171.
- [5] Kaklauskas A., Zavadskas E. K., Gikys M., Gulbinas A. (2001), Efficiency increase of property e-business systems by applying multiple criteria decision support systems // 54emes Journées du Groupe de Travail Européen : "Aid multicritere a la décision", 4 et 5 octobre 2001- Durbuy: "Multicriteria aid for decisions", Durbuy- October 4 and 5, 2001 : programme.p.1-9.
- [6] A. Kaklauskas, E.K.Zavadskas, P.Vainiunas (2001). Efficiency Increase of Real Estate E-Business Systems by Applying Multiple Criteria Decision Support Systems. – Proceedings. Eighth European Real Estate Society Conference, Alicante, June 26-29.
- [7] "Industry resources- CRESA Space Calculator", Available <http://www.naiop.org/resources/assets.shtml> (Accessed: 2002, January).
- [8] "My facilities.com-comfort calculator", Available: <http://www.automationcollege.com/myfacilities/tools/comfortcalculator.asp> (Accessed: 2002, January)
- [9] "QPS, Inc – property analyzer", Available :<http://www.qualityplans.com/propertyanalyser.htm> (Accessed: 2002, January)
- [10] "Archibus, Inc-ARCHIBUS/FM software", Available: <http://www.archibus.com/> (Accessed: 2001, October)
- [11] "FM: Systems, Inc"-FM:Interact and FM:Space software, Available: <http://www.fmsystems.com>, (Accessed: 2002, January)
- [12] "NECA" –Safety Expert Software, Available: [http://www.vulcanpub.com/ecen/article.asp?article\\_id=59995](http://www.vulcanpub.com/ecen/article.asp?article_id=59995) (Accessed: 2002, January)
- [13] "PCSWMM 2000-decision support system", Available: <http://www.chi.on.ca/pcswmmdetails.html> (Accessed: 2002, February)

# The Design of a Web Snapshot Management System for Decision Support Applications

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## Abstract

Database snapshots that are defined and/or delivered via the Web are called web snapshots. This paper addresses the requirements for web snapshot management. A web snapshot management system is proposed; its architecture and functions of the major components are described; new commands are defined to perform web snapshot management activities.

## 1. Introduction

Providing information to support decision-making is a major database application on the World-Wide Web. Many web sites let external users query their databases. Frequently accessed queries can be predefined and retrieved on personalized pages. Internally, Intranets are being used as a platform within an organization for improving communication, information sharing, and for developing business applications to support managerial decision-making. Many companies develop Enterprise Information Portal (EIP) to integrate Intranet applications. Decision support databases and tools such as web-enabled Online Analytical Processing (OLAP) tools are major components of EIP [7]. With the development of decision support activities on Intranet, an easy access to the decision support databases via Intranet is essential to the success of such development.

Database snapshots are an effective way to support predefined and recurrent queries for decision support. They are read-only copies of a selected portion of the database representing the state of the database, and a user's view of the operational data at a fixed point in time (snaptime) [1]. A DEFINE SNAPSHOT statement that defines the snapshot contents initiates a snapshot. In Structure Query Language, SQL, this command might look like:

```
DEFINE SNAPSHOT <snapshot-name>  
AS <query>  
AS OF <snaptime>
```

where <query> can be any valid SQL SELECT command. Database records that satisfy the query are said to be relevant or qualified to the snapshot. Relevant records are materialized and stored under the snapshot-

name. A snapshot is read-only from the user's point of view to maintain its consistency with the database at the snaptime. As updates occur to the database, the snapshot will eventually become "stale" and its value for decision-making will diminish. To bring a snapshot to a new state consistent with the database, the user issues a REFRESH command. In SQL this command is:

```
REFRESH SNAPSHOT <snapshot-name>  
AS OF <new snaptime>
```

Thus, snapshots are similar to "materialized views", however, with the following major differences: 1. Materialized views are created to efficiently answer queries with real time data [4]. Unlike materialized views, snapshots are not designed to provide real time data. 2. User determines the snaptime of a snapshot. In decision support systems users may either prefer not to use, or should not be allowed to use real time data. Many such applications call for historical or end-of-period data. Thus, snapshots are created mainly for decision support applications. 3. Materialized views are updated automatically either by an immediate or deferred update scheme deemed optimal by the system. Snapshots are "refreshed" only when the user explicitly issues a refresh request.

A decision support database (DSDB), such as a data warehouse, is essentially a generalization of the snapshot concept. A DSDB contains data from various sources including internal and external data. Data from these sources are first extracted, cleaned, and then integrated before loaded to the DSDB [5]. A DSDB is read-only, and holds information that is consistent with the various data sources as of a specific point in time. Updates to the DSDB will be done according to a predefined schedule. Thus, a DSDB is a snapshot of the source databases. Its content remains static between two refreshes so that users involved in decision support and analysis activities can work with a relatively static copy of the database.

Database snapshots that are defined and/or delivered via the Web for decision support applications are called web snapshots. Figure 1 depicts the environment and major components involve with web snapshots. Web snapshots are defined on a DSDB. The DSDM maintenance algorithm takes updates from various data sources to

Table 1: Possible combinations of web snapshot materialization and delivery options

Materialization Options

Delivery Options	Materialization Options				
	Database File	HTML File	XML File	OtherFile Formats	Virtual Snapshot
HTMLFile	Conversion	Ready	Conversion	Conversion	Querying & Formatting
XML File	Conversion	Conversion	Ready	Conversion	Querying & Formatting
Other File Formats	Conversion	Conversion	Conversion	Ready/ Conversion	Querying & Formatting

update the DSDB and web snapshots. A web snapshot manager is in charge of the snapshot management activities, such as defining and refreshing snapshots, and delivering web snapshots to the web server. The management of web snapshots is quite different from that in a traditional database system. Some major differences and new requirements are discussed in the following.

**Virtual And Materialized Snapshots** Snapshots defined on a traditional database must be materialized to maintain the consistency at the snaptime. A DSDB is updated by a periodical maintenance schedule, and is static between two updates. Hence, it is consistent with its source databases at the time of the last maintenance. Therefore, snapshots that require the same consistent point as the DSDB do not have to be materialized to maintain their consistency. Hence it is possible to have virtual snapshots defined on a DSDB.

**Snapshot Location** A web snapshot can be easily downloaded to a user's computer as a client-site snapshot. A web page can be saved as a local page. File formats supported by browsers can be opened and/or saved as a local file. File formats not supported by browsers can be downloaded without opening. A client-site snapshot is locally available and saves communication costs if accessed frequently. In a wireless environment client-site snapshots can be implemented as a mobile data warehouse to support mobile agents [6].

**Materialization And Delivery Options** In a traditional database system, snapshots are typically materialized at a centralized location and are materialized as a regular database file. A web snapshot may be delivered as an HTML web page, an XML page, or other file formats such as a spreadsheet. Table 1 illustrates the possible combinations of snapshot materialization and delivery options. A materialized snapshot may be ready to be delivered, or requires conversion to the target format. Virtual snapshots need to be generated by querying the database, and format the results to the target format. In practice, a snapshot's delivery format may be different

from its materialization format. A user may view the snapshot in an HTML format with a browser and download it as a spreadsheet.

**Personalization** Web sites today typically provide personalized web pages to users. A snapshot may be embedded or appear as link in a personalized web page. A web snapshot manager must keep track of users and their snapshots in order to create personalized pages.

**Snapshot Refresh Options** A snapshot is usually refreshed in response to a user's refresh request. Such a refresh is called pull refresh [2]. Alternatively, a snapshot can be refreshed by a push refresh where the snapshot manager refreshes a snapshot automatically and still maintains the user's requirement for consistency. This can be done if a snapshot's snaptime is implicitly changing with time. For example, a user may require the snapshot to be one-day old; the server is able to update the snapshot even without the refresh request.

**Large Number of Users and Small Number of Snapshot Definitions** Web sites typically present forms with interface controls to users to define queries by clicking pre-entered values in the controls. This implies that web sites can predetermine the kind of snapshots that will be defined. The number of unique values in those controls is small when compared with the number of web site users. Consequently the number of unique snapshot definitions that can be constructed is small. Therefore, the ratio of the number of snapshot users to the number of unique snapshot definitions tends to be large. It is very likely that each snapshot may associate with many users. Hence a materialized snapshot may be used to support many users.

This paper proposes a web snapshot management system. This system implements new snapshot management commands that incorporate requirements discussed above. The architecture of the web snapshot manager and the functions of its components will be described. From a user's perspective, managing snapshots involves

defining, accessing, refreshing and deleting snapshots. These commands will be defined in the next section.

## 2. Defining Web Snapshot Management Commands

A web snapshot is the realization of the function  $S(SC(Q, T, D(T)), SM(O, N, L, \{F\}, R))$  where  $SC(Q, T, D(T))$  is a set of parameters specifying the contents of the snapshot, and  $SM(O, N, L, \{F\}, R)$  is a set of parameters specifying the management of the snapshot. The meaning of these parameters is explained below:

SC(Snapshot Contents)

Q: Query operations and logical conditions

T: Snaptime

D(T): Database state at T

SM(Snapshot Management)

O: Snapshot owner

N: Snapshot name

L: Snapshot location

{F}: Snapshot formats where {} indicates repetition

R: Snapshot refresh option

The following DEFINE SNAPSHOT command lets users to enter parameters:

```
DEFINE SNAPSHOT <snapshot-name>
AS <query>
[AS OF snaptime ]
[OWNER IS system | username]
[MATERIALIZE AT client-site| server-site]
[{DELIVER AS file format}]
[REFRESH BY push | pull]
```

In the syntax, clauses enclosed in the brackets are optional; clauses enclosed in the braces may be repeated; words in italic separated by the vertical bars are possible choices for the parameters.

The AS OF clause lets users specify the snaptime. Since the DSDB is basically a snapshot of the source databases, the DSDB is consistent with the source databases at the time the DSDB was last updated in a scheduled maintenance. Without the AS OF clause, the DSDB's consistent point is assumed.

The OWNER IS clause specifies the user of the snapshot. Without it, the snapshot is system-owned. Only registered users can issue DEFINE SNAPSHOT command.

The MATERIALIZE AT client-site clause specifies user's intention to download the snapshot to local site. Note that the snapshot may still be materialized at the server. Without it, the server-site is assumed.

The DELIVER AS lets users specify the format of delivery such as an HTML or XML page. Although users may specify a delivery format, the actual materialization may be different. A snapshot manager may consider other factors (discussed in the next section) in choosing a format for materialization. This clause may be repeated which indicates users may request multiple delivery formats. Hence, it is possible to enter the following clauses in a DEFINE SNAPSHOT command:

```
DELIVER AS xml
DELIVER AS spreadsheet
```

The REFRESH BY clause specifies the snapshot to be refreshed by a push or pull refresh. Without it, the pull refresh is assumed.

Refreshing Snapshots: The REFRESH command refreshes the snapshot to the new snaptime specified in the AS OF clause.

```
REFRESH <snapshot-name>
[AS OF snaptime]
```

A forward refresh is performed when the new snaptime is later than the old snaptime; otherwise a backward refresh is performed. Without the AS OF clause, the DSDB's consistent point is assumed. Note that the REFRESH command applies only to snapshots on the server. To refresh a client-site snapshot, the following RETRIEVE command is proposed.

Retrieving Snapshots The RETRIEVE command delivers a snapshot with the specified format which may be different from its original materialized format.

```
RETRIEVE <snapshot-name>
[{AS file format}]
```

The AS clause may be repeated. Without it, the web page is assumed. Hence, it is possible to enter the following clauses in a RETRIEVE command:

```
AS xml
AS spreadsheet
```

Deleting Snapshots: The delete command is simply:

```
DELETE <snapshot-name>
```

## 3. Components of a Web Snapshot Manager

This section describes the architecture of the web snapshot manager. Figure 2 depicts the major components of the web snapshot manager and the interface among them. It takes snapshot management commands as inputs and delivers requested snapshots as outputs to the web server. The functions of these components are discussed in the following.

**Authorization Control and User Registry** This module maintains user directory and checks that the user has the authorization to issue commands. Only registered users can issue snapshot management commands. Validated commands are passed to the Command Processor.

**Command Processor** This module analyzes the commands, determines their action, and passes them to appropriate components for execution.

**Snapshot Catalog** This module maintains information about web snapshots found in the DEFINE SNAPSHOT command including parameters Q, T, O, N, L, and F, R described earlier. It also maintains a link to the snapshot once it is materialized. This information is needed to support the RETRIEVE and REFRESH SNAPSHOT commands. It updates a snapshot's snaptime once it is refreshed. Information of the deleted snapshots will be removed from the catalog.

**Materialization Optimizer** This module takes snapshot definitions from the catalog and determines the optimal materialization plan. Managing snapshots incurs the cost of generating, refreshing, and delivering snapshots. Generating a snapshot may incur the cost of querying the database and formatting the results to a target format. Refreshing a snapshot may be done by performing a differential refresh or by regenerating the snapshot. Delivering a snapshot may involve the cost of reading and formatting the snapshot to a target format. Without describing the optimizer in details major issues involved in deciding an optimal plan are discussed in the following.

. Choosing a criterion for optimization: A typical criterion in selecting an optimal snapshot materialization is to minimize the total snapshot management costs. For web snapshots, however, reducing the response time of delivery is important in maintaining the quality of web site service.

. Choosing between materialization and virtual implementation: Not all web snapshots require materialization. The frequency of accessing a snapshot is an important parameter in making this decision. A frequently accessed snapshot typically requires materialization.

. Choosing between one materialized format and multiple formats: The DEFINE SNAPSHOT and the RETRIEVE SNAPSHOT commands let users specify multiple delivery formats. Materializing in multiple formats will reduce the response time but may require more refresh costs and vice versa.

. Choosing between using one materialized copy to support one snapshot and multiple snapshots: Snapshots with identical (or significantly overlapping) definitions and with the same consistency requirement can be supported more efficiently with a single materialization.

**Refresh Optimizer** This module processes the REFRESH commands. The major functions of this module are:

. Choosing an optimal refresh method: A snapshot can be refreshed by a full regeneration or by a differential refresh. Typically, a frequently refreshed snapshot or a snapshot with only a few updates can be refreshed more efficiently with a differential refresh.

. Maintaining update log: The REFRESH command lets users to specify a new snaptime, which may be before or after the current snaptime. In order to support this refresh capability, the optimizer must maintain a log of updates. Updates to a base table are either deletions or insertions if modifications are treated as the deletion of the before-image followed by the insertion of the after-image. A typical log design is: (TimeStamp, UpdateFlag, UpdatedRecord) where the TimeStamp records the update time and the UpdateFlag is a flag indicating deletion or insertion [3]. This type of log keeps updates in chronological order. Since snapshots are defined on a DSDB, the updates gathered by the DSDB maintenance algorithm can be used to refresh snapshots.

. Generating refresh messages: Updates between the old snaptime and the new snaptime can be generated from the log. These refresh messages are sent to the materialization optimizer to refresh the materialized copy.

Once the refresh is done, the refresh optimizer will notify the snapshot catalog to update the snaptime.

**Retrieve and Delivery Module** This module processes the RETRIEVE commands. It retrieves the snapshot from the materialization optimizer, converts it to the format requested by the user, and delivers it to the web server.

## 4. Summary

This paper addresses issues and requirements for the management of web snapshots. Database snapshots that are defined and/or delivered via the Web are called web snapshots. They are used mainly for decision support applications in a Web environment. New commands are defined to perform web snapshot management activities. A web snapshot management system is proposed; the functions of the major components in this system are described.

## References

[1] Adiba, M. & Lindsay, B. (1980). Database snapshots. Proceedings of the 6th International Conference on Very Large Data Bases, pp. 86-91.

[2] Aksoy, D., Franklin, M., Zdonik, S. (2001). Data Staging for On-Demand Broadcast. Proceedings of the 27<sup>th</sup> VLDB Conference, Roma, Italy, 2001

[3] Chao, D., Diehr, G., & Saharia, A. (1996) Maintaining Join-based Remote Snapshots Using Relevant Logging. Proceedings of the Workshop on Materialized Views, ACM SIGMOD, Montreal, Canada, 1996

[4] Labrinidis, A. & Roussopoulos, N. (2000). Webview Materialization. ACM SIGMOD International Conference on Management of Data, May 14-19, 2000

[5] Gray, P., Watson, H. (1998). Decision Support in the Data Warehouse. Prentice Hall, 1998

[6] Lee, K., Si, A., and Leong, H. (1998). Incremental View Update for a Mobile Data Warehouse. ACM Symposium on Applied Computing, Atlanta, 1998

[7] Murray, G. (1999). Making Connections with Enterprise Knowledge Portals. White Paper, Computerworld, Sept. 6, 1999

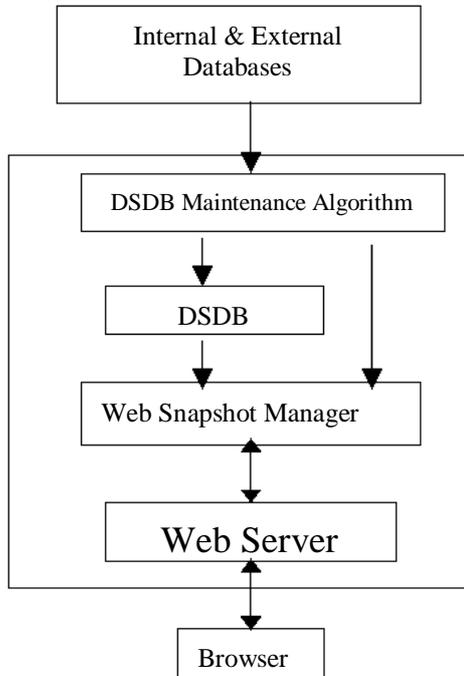


Figure 1: Components of web snapshot management for decision support .

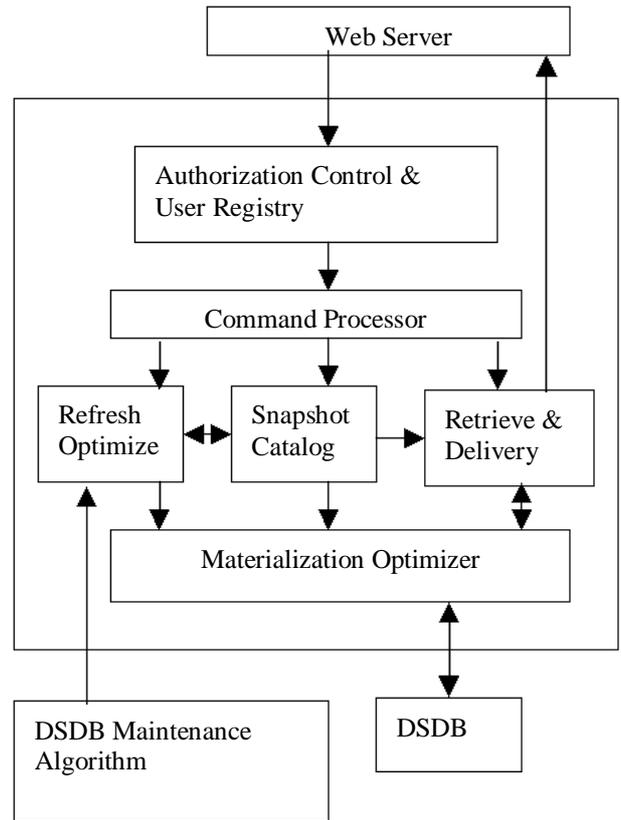


Figure 2: Components of a web snapshot manager

# Group Decision Making for a Fuzzy Software Quality Assessment Model to Evaluate User Satisfaction

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## Abstract

Information techniques have brought us tremendous benefit, whereas people are increasingly depended on lots of information systems. Therefore, how to establish an assessment model to choose a better software quality suitable for end-users is an important issue. This study is to present an algorithm of the group decision makers with crisp or fuzzy weights to tackle the integrated software quality for evaluating user satisfaction using fuzzy set theory, where the grades of quality and the grade of importance of quality items are assessed by linguistic values represented by triangular fuzzy numbers. The proposed algorithm is more flexible and useful than the ones that have presented before, since the weights against decision makers are considered.

## 1. Introduction

During the past decades, information industries have been flourishing in Taiwan. Compared to hardware information technologies, software engineering needs to improve more because more efforts are put into the development process than the control of software quality. Software products are powerful but hard to revise, modify, expand or transfer. Therefore, how to promote the quality of software is important.

Software quality was assessed with software attributes but its complexity and unpredictable nature cannot be easily processed. Therefore, how to build an effective software quality measure model becomes an important issue. In the early 1990s, the software engineering community attempted to consolidate the many views of quantity into one model that could act as a worldwide standard for measuring software quantity. The result was ISO 9126, a hierarchical model with six major attributes contributing to quality [7]. Since ISO 9000 is already widely used in industry and also corresponds with Satty's Analytical Hierarchy Process (AHP) [8], as shown in Table 1, we denote the attribute to be  $X_i$  and the items as  $X_{ij}$  [4-5, 7, 9].

Based on the algorithm developed in [4], Wang and Chiang [9] presented a software quality assessment model to evaluate user satisfaction. In [2], Fey et al. presented

the simplified algorithm to tackle the user satisfaction. In [2, 9], they assumed the relative important weights of each evaluator to be the same. But, in general, the relative importance of each decision maker or expert probably may be widely different. Sometimes there are important experts in the group decision making, the final decision is influenced by the different importance of each expert. Therefore, the best method of aggregating experts' assessing data must consider the degree of importance of each expert in the aggregation procedure.

We reviewed the Wang and Chiang method [9], Fey et al. method [2] in Section 2, 3, respectively. In Section 4, we proposed the fuzzy group decision making for evaluating the user satisfaction.

## 2. A review of Wang and Chiang's method [9]

Based on Lee [4], when evaluating each item of software quality, we assign its grade of quality, and grade of importance [4, 9]. Then we range both of them into 11 ranks, as shown in Table 2 [4, 9].

We made the linguistic values 1, 2, ..., 11 into corresponding reasonable fuzzy numbers with triangular membership functions as listed in Table 3 [4, 9].

By the multiplication of fuzzy number of grade of quality and fuzzy number of grade of importance, and the defuzzification  $g(a, i)$  by the centroid method, Lee derived the values of  $g(a, i)$  as shown in [4]. Based on [4], Wang and Chiang [9] constructed the ISO 9126 model into the structure model as shown in Table 4. The weight of quality attribute  $X_i$  is represented as  $W_i$ , while  $W_{ij}$  denotes the weight of item  $X_{ij}$ .

The criteria ratings are linguistic variables with values  $V_1, V_2, V_3, V_4, V_5, V_6, V_7$  (as shown the figure in [4]), where  $V_1 =$  extra low,  $V_2 =$  very low,  $V_3 =$  low,  $V_4 =$  middle,  $V_5 =$  high,  $V_6 =$  very high,  $V_7 =$  extra high. These linguistic values are treated as fuzzy numbers with triangular membership functions [4]. Let

$V = \{V_1, V_2, V_3, V_4, V_5, V_6, V_7\}$  be the set of the criteria rating of quality for each item. By fuzzy relation on  $X_i \times V$ , we can form a fuzzy assessment matrix  $M(X_i)$  for  $X_i \times V$ . Thus, fuzzy assessment matrix  $M(X_2)$  for  $X_2$  is formed as the following [4]:

$$M(X_2) = \begin{bmatrix} V(a_{21}, i_{21}, 1) & V(a_{21}, i_{21}, 2) & \dots & V(a_{21}, i_{21}, 7) \\ V(a_{22}, i_{22}, 1) & V(a_{22}, i_{22}, 2) & \dots & V(a_{22}, i_{22}, 7) \\ V(a_{23}, i_{23}, 1) & V(a_{23}, i_{23}, 2) & \dots & V(a_{23}, i_{23}, 7) \end{bmatrix}$$

By using the same way, fuzzy assessment matrices  $M(X_1), M(X_3), \dots, M(X_6)$  can be formed respectively. Then the first-stage aggregated assessment quality  $R_2 = (W_{21}, W_{22}, W_{23}) \times M(X_2)$  for attribute  $X_2$ .  $R_1, R_3, \dots, R_6$  can be derived respectively.

The rate of aggregated quality of software quality for user satisfaction is calculated by using the second-stage assessment as the following formula:

$$(fW_1, fW_2, fW_3, fW_4, fW_5, fW_6, fW_7) \times \begin{bmatrix} R_1 \\ R_2 \\ R_3 \\ R_4 \\ R_5 \\ R_6 \end{bmatrix}$$

The final rate of aggregated quality of software quality for user satisfaction is then defuzzified by centroid method and becomes:

$$FW = \frac{\sum_{i=1}^7 VG(i) \times fW_i}{\sum_{k=1}^7 fW_k} = \sum_{i=1}^7 VG(i) \times fW_i$$

where  $\sum_{k=1}^7 fW_k = 1$ ,  $VG(i), i = 1 \dots 7$ , which are the centroids of  $V_1, V_2, \dots, V_7$  [4] and  $VG(1)=0.0556$ ,  $VG(2)=0.1667$ ,  $VG(3)=0.3333$ ,  $VG(4)=0.5$ ,  $VG(5)=0.6667$ ,  $VG(6)=0.8333$ ,  $VG(7)=0.9444$ .

### 3. A review of Fey et al. method [2]

Step 1. Let

$$R2(k) = \frac{\sum_{j=1}^{n(k)} W_{(k,j)} * g(r_{kj}, i_{kj})}{\sum_{j=1}^{n(k)} W_{(k,j)}}$$

$$= \sum_{j=1}^{n(k)} W_{(k,j)} * g(r_{kj}, i_{kj})$$

(since  $\sum_{j=1}^{n(k)} W_{(k,j)} = 1$ ),  $k=1, 2, \dots, 6$ , where  $n(k)$  is

the number of quality item for attribute  $X_k$ , then we have  $n(1)=4, n(2)=3, n(3)=3, n(4)=4, n(5)=4, n(6)=2$ ;  $g(r_{kj}, i_{kj})$  is the rate of quality item  $X_{kj}$  appeared in [4];  $W_{(k,j)}$  is the weight of quality item  $X_{kj}$ .

Step 2. The final rate of aggregative quality of the software quality for the user satisfaction is by the centroid method as follows:

$$\text{Let } R1 = \frac{\sum_{k=1}^6 W_{(k)} * R2(k)}{\sum_{k=1}^6 W_{(k)}} = \sum_{k=1}^6 W_{(k)} * R2(k)$$

(since  $\sum_{k=1}^6 W_{(k)} = 1$ ), where  $W_{(k)}$  is the weight of

attribute of  $X_k$ , for  $k=1, 2, \dots, 6$ . Then, the value of  $R1$  is the rate of aggregative quality of the software system for the user satisfaction.

### 4. A fuzzy group decision makers with crisp or fuzzy weights to evaluate the user satisfaction

In [5], Lee proposed an algorithm of the group decision makers with crisp or fuzzy weights to tackle the rate of aggregative risk in software development in fuzzy circumstances by fuzzy set theory during any phase of the life cycle. We applied this algorithm to this Section as follows:

Step 1: Let  $SAT(k)$  be the rate of aggregative quality of the software system for the user satisfaction for the evaluator  $D_k$ 's assessing data, i.e., let  $SAT(k)$  be  $FW(k)$  in Section 2, or  $R1(k)$  in Section 3.

Step 2:

(A) Corresponding to the crisp relative importance of each decision maker or evaluator:

We assign  $d_1, d_2, \dots, d_n$  to be the relative weight of each evaluator  $D_1, D_2, \dots, D_n$ . Then, we define

$$w(j) = \frac{d_j}{\sum_{k=1}^n d_k}, \text{ for } j=1, 2, \dots, n$$

to be the normalization of  $d_1, d_2, \dots, d_n$ .

(B) Corresponding to the fuzzy relative importance of each decision maker or evaluator:

We assign the relative fuzzy weight  $\tilde{w}_j = (w_{j1}, w_{j2}, w_{j3})$  to be the triangular fuzzy number in  $[0, 1]$  for the evaluator  $D_j$  for  $j=1, 2, \dots, n$ .

Defuzzified  $\tilde{w}_j = (w_{j1}, w_{j2}, w_{j3})$  by the classical centroid method, we obtain

$$w_j = \frac{1}{3}(w_{j1} + w_{j2} + w_{j3})$$

Normalize  $w_j$ , we obtain the degree of importance

$w(j)$  for the evaluator  $D_j$  as follows:

$$w(j) = \frac{w_j}{\sum_{k=1}^n w_k}, \text{ for } j=1, 2, \dots, n.$$

Step 3: By Step 1 and Step 2, we have that the rate of aggregative quality of the software system for the user satisfaction for the evaluators with weights  $w(1), w(2), \dots, w(n)$  is

$$SAT\_User = \sum_{j=1}^n SAT(j) \cdot w(j)$$

The value of  $SAT\_User$  is the rate of aggregative quality of the software system for the user satisfaction for the evaluators' assessing data. If there is only one evaluator to evaluate then we have the same formula as in [2] and [9].

## 5. Conclusion

The proposed algorithm of the group decision makers or evaluators with crisp or fuzzy weights for

evaluating rate of aggregative quality of the software system for the user satisfaction is more useful and flexible than Wang and Chiang in [9] and Fey et al. in [2], since the weights against evaluators /decision makers are considered.

## References

- [1] K. K. Aggarwal and Yogesh Singh, "Software Reliability Apportionment using the Analytic Hierarchy Process", Software Engineering Notes, Vol. 20, No.5.
- [2] Yeh-Jui Fey, Tsung-Yen Lee, and Huey-Ming Lee, "A new method for a fuzzy software quality assessment model to evaluate user satisfaction", Seventh ISSAT International Conference on RELIABILITY AND QUALITY IN DESIGN, Aug. 8-10, 2001, Washington DC
- [3] B. Kitchenham, S. Pfleeger, "Software Quality: the Elusive Target", IEEE SOFTWARE (1996,1)
- [4] Huey-Ming Lee, "Applying fuzzy set theory to evaluate the rate of aggregated risk in software development", Fuzzy Set and Systems 79 (1996) 323-336.
- [5] Huey-Ming Lee, "Generalization of the group decision making using fuzzy set theory for evaluating the rate of aggregated risk in software development", Information Sciences 113 (1999) 301-311
- [6] C.-C. Lu and M.-C. Lee, "Tool for Software Quality Assurance: ISO 9000-3", Quality Control, Vol. 30(8), 655-662, 1994 (in Chinese).
- [7] S. Pfleeger, "Software Engineering --- Theory and Practice", (1998) PrenticeHall, Inc.
- [8] T. L. Satty, "The Analytic Hierarchy Process", New York: McGraw-Hill (1980).
- [9] Chien-Chung Wang and Jen-Hong Chiang, "A fuzzy software quality assessment model to evaluate user satisfaction", Twenty Ninth Annual Meeting of the Western Decision Sciences Institute, Maui-Hawaii, April 18-22, (2000), PP. 1230-1233

Table 1: The ISO 9126 Sample Quality Model [6]

	Attribute ( $X_i$ )	Item ( $X_{ij}$ )
Software quality	$X_1$ Functionality	$X_{11}$ Suitability
		$X_{12}$ Accuracy
	$X_2$ Reliability	$X_{13}$ Interoperability
		$X_{14}$ Security
		$X_{21}$ Maturity
		$X_{22}$ Fault tolerance
		$X_{23}$ Recoverability
	$X_3$ Usability	$X_{31}$ Understandability
		$X_{32}$ Learnability
		$X_{33}$ Operability
	$X_4$ Maintainability	$X_{41}$ analyzability
		$X_{42}$ Changeability
		$X_{43}$ Stability
		$X_{44}$ Testability
$X_5$ Portability	$X_{51}$ Adaptability	
	$X_{52}$ Installability	
	$X_{53}$ Conformance	
	$X_{54}$ Replaceability	
$X_6$ Efficiency	$X_{61}$ Time behavior	
	$X_{62}$ Resource behavior	

Table 2: Linguistic values of grades of quality and grades of importance

Eleven ranks of grade of quality	Eleven ranks of grade of importance
1: Definitely low	1: Definitely important
2: Extra low	2: Extra unimportant
3: Very low	3: Very unimportant
4: Low	4: Unimportant
5: Slightly low	5: Slightly unimportant
6: Middle	6: Middle
7: Slightly high	7: Slightly important
8: High	8: Important
9: Very high	9: Very important
10: Extra high	10: Extra important
11: Definitely high	11: Definitely important

Table 3: Fuzzy numbers of grade of quality and grade of importance

Grade of quality	Fuzzy number	Grade of importance	Fuzzy number
1	$N_1=(0.0,0.0,0.1)$	1	$N_1=(0.0,0.0,0.1)$
2	$N_2=(0.0,0.1,0.2)$	2	$N_2=(0.0,0.1,0.2)$
3	$N_3=(0.1,0.2,0.3)$	3	$N_3=(0.1,0.2,0.3)$
4	$N_4=(0.2,0.3,0.4)$	4	$N_4=(0.2,0.3,0.4)$
5	$N_5=(0.3,0.4,0.5)$	5	$N_5=(0.3,0.4,0.5)$
6	$N_6=(0.4,0.5,0.6)$	6	$N_6=(0.4,0.5,0.6)$
7	$N_7=(0.5,0.6,0.7)$	7	$N_7=(0.5,0.6,0.7)$
8	$N_8=(0.6,0.7,0.8)$	8	$N_8=(0.6,0.7,0.8)$
9	$N_9=(0.7,0.8,0.9)$	9	$N_9=(0.7,0.8,0.9)$
10	$N_{10}=(0.8,0.9,1.0)$	10	$N_{10}=(0.8,0.9,1.0)$
11	$N_{11}=(0.9,1.0,0.0)$	11	$N_{11}=(0.9,1.0,0.0)$

Table 4: The contents of structure model [2, 4, 9]

Attribute	Weight ( $w_i$ )	Item	Weight ( $w_{ij}$ )	Grade of quality (a)	Grade of importance (i)	Defuzzication $g(a, i)$
X <sub>1</sub>	W <sub>1</sub>	X <sub>11</sub>	W <sub>11</sub>	a <sub>11</sub>	i <sub>11</sub>	$g(a_{11}, i_{11})$
		X <sub>12</sub>	W <sub>12</sub>	a <sub>12</sub>	i <sub>12</sub>	$g(a_{12}, i_{12})$
		X <sub>13</sub>	W <sub>13</sub>	a <sub>13</sub>	i <sub>13</sub>	$g(a_{13}, i_{13})$
		X <sub>14</sub>	W <sub>14</sub>	a <sub>14</sub>	i <sub>14</sub>	$g(a_{14}, i_{14})$
X <sub>2</sub>	W <sub>2</sub>	X <sub>21</sub>	W <sub>21</sub>	a <sub>21</sub>	i <sub>21</sub>	$g(a_{21}, i_{21})$
		X <sub>22</sub>	W <sub>22</sub>	a <sub>22</sub>	i <sub>22</sub>	$g(a_{22}, i_{22})$
		X <sub>23</sub>	W <sub>23</sub>	a <sub>23</sub>	i <sub>23</sub>	$g(a_{23}, i_{23})$
X <sub>3</sub>	W <sub>3</sub>	X <sub>31</sub>	W <sub>31</sub>	a <sub>31</sub>	i <sub>31</sub>	$g(a_{31}, i_{31})$
		X <sub>32</sub>	W <sub>32</sub>	a <sub>32</sub>	i <sub>32</sub>	$g(a_{32}, i_{32})$
		X <sub>33</sub>	W <sub>33</sub>	a <sub>33</sub>	i <sub>33</sub>	$g(a_{33}, i_{33})$
X <sub>4</sub>	W <sub>4</sub>	X <sub>41</sub>	W <sub>41</sub>	a <sub>41</sub>	i <sub>41</sub>	$g(a_{41}, i_{41})$
		X <sub>42</sub>	W <sub>42</sub>	a <sub>42</sub>	i <sub>42</sub>	$g(a_{42}, i_{42})$
		X <sub>43</sub>	W <sub>43</sub>	a <sub>43</sub>	i <sub>43</sub>	$g(a_{43}, i_{43})$
		X <sub>44</sub>	W <sub>44</sub>	a <sub>44</sub>	i <sub>44</sub>	$g(a_{44}, i_{44})$
X <sub>5</sub>	W <sub>5</sub>	X <sub>51</sub>	W <sub>51</sub>	a <sub>51</sub>	i <sub>51</sub>	$g(a_{51}, i_{51})$
		X <sub>52</sub>	W <sub>52</sub>	a <sub>52</sub>	i <sub>52</sub>	$g(a_{52}, i_{52})$
		X <sub>53</sub>	W <sub>53</sub>	a <sub>53</sub>	i <sub>53</sub>	$g(a_{53}, i_{53})$
		X <sub>54</sub>	W <sub>54</sub>	a <sub>54</sub>	i <sub>54</sub>	$g(a_{54}, i_{54})$
X <sub>6</sub>	W <sub>6</sub>	W <sub>61</sub>	W <sub>61</sub>	a <sub>61</sub>	i <sub>61</sub>	$g(a_{61}, i_{61})$
		W <sub>62</sub>	W <sub>62</sub>	a <sub>62</sub>	i <sub>62</sub>	$g(a_{62}, i_{62})$

# Development of a DSS to Estimate the Sales for the Retailing Industry in Taiwan

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## Abstract

An algorithm is constructed in this study to estimate the market sizes of daily commodity in Taiwan based on the sampled sales information provided by retailer chains. Though retailer chains provide sampled sales information from only small portions of their retailing stores, they expect to receive more valuable processed information from that. As result of this research, a DSS is proposed to compute value-added information from this joint sales information database, namely the estimation information. Through certain public accessible data such number of stores by each chain and retailers' financial reports, the sampled sales information can be transferred to the market size information of each item in Taiwan. Two similar algorithms are constructed for convenient stores and supermarkets/hypermarkets separately. A simple integration method is used to combine these results. Finally, a DSS is built based on these estimation algorithms and is implemented successfully.

## 1. Introduction

Sales information is always the important fundamental information that the decisions of the future sales and inventory policies were based on. However, not all the retailers have the ability to utilize information technology. Some retailers are unable to process and analyze the sales information further due to the lack of investment in capacity, capital, and people. Therefore, Department of Commerce in Ministry of Economic Affairs in Taiwan support a project initialized by Computer and Communications Research Laboratories (CCL) of Industrial Technology Research Institute (ITRI) to analyze and integrate the demands from all the retailers regarding to the sales information for the retailing industry in Taiwan. After analyzing the demands, CCL/ITRI setup Distribution Information Service Center, or DISC, to study and fulfill information requirement of retailers in Taiwan in May 2000. DISC collected sampled sales information from the retailers and constructed a joint sales information database, called "Retailing Sales Information Sharing System" or RSISS. There are currently more than 100,000 retailing items with Universal Product Code (UPC) in this database and all of them have been classified with three levels of classification codes.

As more and more retailers agree to cooperate in this project, the joint sales information database of RSISS is growing with more and more data. The retailers who joint

this project is expecting to receive more value-added information such as estimation, prediction, etc in the future. In light of this expectation, DISC endows a project to construct a DSS that estimates the sales of retailing industry in Taiwan based on the sample sales data. This DSS is constructed and implemented successfully through the cooperation and efforts of DISC, Department of Information Management and Department of Business Administration in National Taiwan University.

## 2. Literature Review

As mentioned in Andreasen [1] and Rapp etc [12], the research in Marketing in the past usually concentrated on certain subject and solved specific problem from scenario analysis, to problem formulation, to data collection, to result finding. However, this type of research ignores the supply-demand environment issues and the relationship of marketing activities among different chain stores. The study in Marketing Research Systems (MRS) [4] or Marketing Information Systems (MKIS) [2] arises for this reason. Through collecting customer and sales information, a sales and marketing related database can be constructed to provide continuous and relevant sales/marketing reports. Morris etc [11] surveyed the views of 101 marketing managers toward MRS and found that they think positive of MRS though these managers don't exactly know what computer technology would affect them. Li [8] tracks the development of MKIS among the Fortune 500 companies in 10 years. He concludes that the usage of MKIS is getting more and more complicated and matured but the marketing managers are still unsatisfied with the reports and information provided by MKIS. Talvinen etc [15] also survey the senior marketing managers of 156 wholesalers in Finland and find that MKIS plays a crucial role in marketing policy making.

Constructing a complete MRS or MKIS needs consistent and long-term efforts as well as computerized capability to clean, integrate, classify, and transform data. Talvinen [14] suggests a specific system architecture of a MKIS with important processing subsystems such as decision support, planning, and internal/external control. Amaravadi etc [2] think the future trend of MKIS is Intelligent Knowledge System with marketing/sales knowledge base and decision support function. With a complete sales/marketing database, more and more researchers focus their efforts on the decision support functions that could be added on the system. Higby etc [6]

found that information after cleaning, classification, and computation is much more valuable to marketing managers in terms of decision making. Li etc [7] analyzes the utilization of MKIS in Fortune 500 companies and finds that marketing managers commonly use MKIS/Decision Support System/Expert System in their decision making and are more interested in value-added information such as sales forecast and market share estimation. Li [9] surveys the conditions of using MKIS in 1000 small US companies and finds a relationship between sales and probability of MKIS utilization. In other words, the larger the sales of a company, the more possible the company has a MKIS. As to how the company applies MKIS to marketing policies, 67.7% are for pricing strategy, 65.8% for new product evaluation, 61.8% for advertisement media selection, 52.6% for product out-of-market, 46.1% for budget, and 43.4% for salesperson allocation. Li etc [10] found that the support of MKIS to management is in 4 aspects: planning (44%), control (19%), organization (15%), direction (14%), and personnel (8%). They also think that more and more IT specialists joint the sales/marketing department to help salesperson or marketing personnel obtaining more value-added information without relying too much on MIS/IT department.

Adopting mathematical modeling and statistics method is also a future trend of MKIS to provide more valuable decision support functions. Among all the value-added information, sales estimation and forecast is the most important and common one provided by MKIS [7, 16, 17]. Marketing managers from all types of industries are all eager to know the sales estimation of a single product or the whole company, or the estimation of future market shares. Higby etc [6] also find that 66% of MKISs provide support on sales estimation/forecasting. The conclusion can also be found in Li etc [7]. Current research on data mining also showed the same result. Berry etc [3] think that one of the important functions provided by data mining is estimation followed by prediction. Concluded from the above reviews, estimation is a very important value-added information provided by MRS or MKIS. Therefore, this research proposes to build a DSS upon a joint MKIS, namely RSISS, to estimate the retailing market size of each individual item in Taiwan.

### 3. Problem Description

The problem faced by DISC is to estimate the market size of every individual product with UPC based on the sampling sales information provided by the retailer chain stores. There are three major types of retailing stores in Taiwan: convenient stores, supermarkets, and hypermarkets. Old-fashioned grocery stores now exist only in the remote areas and take up only a very small part of the total sales of the retailing industry in Taiwan. They are usually not equipped with IT capability and thus, are not able to provide digital sales information to DISC. Six major chains of convenient stores capture about 95% of the

convenient store market in Taiwan and joint the project of Retailing Sales Information Sharing System (RSISS) founded by DISC in May 2000. As to the supermarket chains, major players capture more than 50% of the supermarket sales in Taiwan and joint the project of RSISS a year later than the convenient-store chains in May 2001. More supermarkets under negotiation are interested in joining the project. It is estimated that 85% of the supermarkets will be included in this project in the end of 2002. The negotiation of hypermarkets' cooperation in the project is currently under way. A full-scale cooperation from the major hypermarkets is expected to begin in July 2003.

With so many partners in the project, it is impossible to process all the sales information from all the stores. As to the end of May 2001, there are more than 6,250 convenient stores, 570 supermarkets, and 100 hypermarkets in Taiwan. On the average, each convenient store carries more than 4000 items with UPC while each supermarket carries more than ten thousand UPC items and each hypermarket carries forty thousand UPC items. Not only is it impossible to process such large scale of sales information, it is also unrealistic to ask retailer chains to submit all the sales information of all stores. To balance the information-sharing scale, each chain of convenient stores samples sales information of 100 stores. As to supermarkets, most of the supermarket chains have less than 40 stores except Wellcome. Therefore, Wellcome provides sales information of 40 stores out of its 105 stores while others provide sales information of all their stores. From the geographic point of view, the scattering of the stores around Taiwan is not balanced. DISC has divided Taiwan into three geographic areas: North, Center, and South. More than 60% of the retailing stores are located in Northern Taiwan. As result of negotiation, each convenient store chain provides sales information of 40 stores from north, 20 from center, and 20 from south if there are enough stores in each area. For supermarkets, Wellcome provides sales information of 20 stores from north, 10 from center, and 10 from south while others provide sales information of all their stores based on the locations. Random sampling is not applicable here since the scales of the convenient store chains vary significantly. To balance the differences among sampling stores, DISC requires the samples to be taken from the top 50% list for all the convenient store chains and Wellcome supermarkets. From the above sampling process, the problem of estimating sales faced by DISC can be depicted as Figure 1. In other words, the sales estimation of each individual item with UPC in Taiwan is computed based on the sampled sales data collected each month by DISC. The sales estimation can be seen as a summarized figure or be analyzed from different points of views.

### 4. Estimation Algorithm

Two separate but similar heuristic algorithms are constructed to estimate the market size of convenient

stores and supermarkets/hypermarkets. A simple computation module is then used to combine these two results and provides the final estimation of the entire retailing market as seen in Figure 2. These two heuristic algorithms are very similar in terms of estimating the market sizes but different in the analysis dimensions. Two types of analysis dimensions are applied: item and store characteristics. From item point of view, some items are seasonal or regional while others are not. In order to aggregate the similar effect, items are grouped into three levels of categories: first-layer, second-layer, and third-layer. Through the years, DISC has developed a standard classification mechanism to the items in RSISS. In this study, the same classification method is adopted. For the store characteristics, geographic areas, living zones of convenient stores, and sizes of supermarkets and hypermarkets are all the related analysis dimensions.

Six steps are involved in the algorithm of estimating the market size of convenient stores for each item as seen in Figure 3 and are elaborated below.

- **Step 1:** Compute the average sales at each store of each chain: The reason to compute this average is that some chains might not be able to provide sales information for the stores in all areas. However, those sales will have to be included in the estimation. Therefore, other chain K will be used as the reference to help estimating sales in those areas without any sales information. However, the scale of reference chain is different from the chain to be estimated in terms of sales. To adjust the difference in scales of different chains, average sales at each store of each chain will have to be calculated first.
- **Step 2:** Compute the average sampling sales of each first-layer category of each chain in each area: The reason to compute this average is due to the customer's behavior differences among different areas. However, to compute the average for each individual item is an impossible task due to the enormous amount of item information. In order to reduce the amount of calculation efforts, first-layer category is used instead of individual item. To obtain the average, compute the total sales of sampling stores for each first-layer category of the reference chain of Chain R in reference area of area A first. Then compute the ratio of average store sales of Chain R in area A over the average store sales of its reference chain and area and adjusting the ratio by number of stores sampled by chain R and its reference chain.
- **Step 3:** Compute the percentage of the total sales for each first-layer category of each chain occurs in each area after normalization: The percentage of total sales at chain R occurred in area A of chain R can be collected from retailers. However, it is for the summary of all items instead of individual items. However, to calculate the

percentages for individual items is a difficult job due to the same reason mentioned above. Since products in the same first-level category possess similar characteristics, this percentage is computed for each first-level category. To get the percentage, compute the total sales of each first-layer category at sampling stores of each chain in each area. Sum up the total sales of every first-layer category for each chain next. Then, calculate the percentage by dividing the above two figures. However, the sum of all percentages for each first-layer category in each area of each chain might not be 1. Thus, the percentages need to be normalized to make the sum of percentages equal to 1.

- **Step 4:** Compute the adjustment factor of the total sales for each first-layer category of each chain occurs in each zone after normalization: The purpose of this step is similar to step 3 but from different angle, namely living zones. To attain this adjustment factor, compute the total sales of sampling stores for each first-layer category of each chain in each living zone first. Sum up the total sales of the first-layer category J for chain R next. Then, compute the percentage for first-layer category J of chain R adjusted by the scattering of stores.
- **Step 5:** Compute the estimated total sales amount of each item in each living zone and each area: Compute the total sampling sales of each item in every zone Z of every chain first. Then, divide it by the percentage of the total sales at chain R occurred in the sampling stores and multiply the result by the adjustment factor computed in step 4 to obtain the total sales of each item in each zone of each chain. Multiply the percentage obtained in step 3 to the above result to get the sales of each item in each zone and each area of each chain. Finally, sum up the total from each chain to be the total sales amount of each item in every zone and every area.
- **Step 6:** Compute the estimated total sales amount of each first-, second-, and third-layer category in every zone and every area: To do this, simply add up the result from step 5 for all items belong to each first-, second-, and third-layer category in every zone and every area.

Certain assumptions have to be made in order to finish this algorithm and are elaborated as follows:

1. The sales pattern of each item in the same first-layer category is similar. Under this assumption, each item can apply the same percentage of the total sales for each first-layer category of each chain occurs in each area after normalization.
2. The sales pattern of each store in the same area of the same chain is similar, which implies that the

average sales amount of each store in the same area of the same chain is also very similar.

3. The sales pattern of each store in the same living zone of the same chain is similar, which implies that the average sales amount of each store in the same living area of the same chain is similar, too.

Six steps are also involved in the algorithm of estimating the market size of supermarkets or hypermarkets for each item as seen in Figure 4. As comparing with the algorithm for convenient stores, the differences lie in the analysis dimensions. In the algorithm for convenient stores, living zone is a very important analysis dimension, while size of store is used in the algorithm for supermarkets. Two different sizes are adopted in the algorithm: large and small. Stores with spaces larger than 661 square meters (7200 square feet or 200 pings) are defined as large while else are small.

After the previous two algorithms are run, the results are imported and combined by the following steps:

- **Step 1:** Compute the total sales amount of each item in each area
- **Step 2:** Sum up the total sales of each item in each area by  $\sum_i \alpha_i \cdot (\text{sales estimated for retailer type } i \text{ for each area})$  where  $\alpha_i$  is the percentage of the sales of retailer type  $i$  included in RSISS.
- **Step 3:** Compute the estimated total sales of each first-, second-, and third-layer category in each area.

In the above algorithm, several parameters are assumed known and constant. However, difficulties arise when started to collect these needed parameters. The total number of stores of each chain in each area is public data and can be collected from government reports each month. The percentage of the total sales at chain  $R$  occurring in the sampling stores of chain  $R$  or  $P(R)$  is the most important ratio that needs to be gathered but all the retailing chains refuse to provide this information because of ferocious market competition. The percentage of total sales at chain  $R$  happened in area  $A$  of chain  $R$  or  $W(R, A)$  should be provided by all the retailing chains but is also rejected for the same reason. Therefore, an evaluation process is proposed in this section to compute the two important ratios,  $P(R)$  and  $W(R, A)$ .

- **Evaluation of  $P(R)$ :** By definition,  $P(R)$  is the percentage of the sales at the sampled stores in the total sales at all stores of chain  $R$  each month. Sales information at the sampled stores of chain  $R$  is collected every month. Therefore, the total sales amount at the sampled stores of chain  $R$  can be easily computed every month. The total revenue of chain  $R$  can also be obtained from the

companies' monthly financial reports. However, several items such as prepared food, fee-collecting services, etc in revenues should not be included because they are not sales of UPC items. About 15 to 20 percent of the revenue should be excluded from the total sales in the financial reports used to compute  $P(R)$ . For each chain,  $P(R)$  is equal to the total sales amount at the sampled stores divided by 85% or 80% of the total revenue found in the financial reports.

- **Evaluation of  $W(R, A)$ :** To estimate  $W(R, A)$ , which is the percentage of total sales at chain  $R$  happened in area  $A$  of chain  $R$ , numbers of stores in each area for each chain is collected every month. By interviewing the chain managers, it is known that on average, the sales of a store located in the south or central area is about  $q\%$  less than the sales of a store located in the north where  $q$  is usually between 10 to 15. Therefore,  $W(R, A)$  can be computed on this base.

## 5. System Structure and Implementation

The position of this Estimating DSS in the RSISS is shown as the gray-fill box in Figure 5. The system is built on MS Server 2000 environment with MS SQL as database server and JDE as the development tool. The architecture of servers used in this DSS is shown in Figure 6. The system is built and tested on a PC server with Pentium IV 1.7GB CPU and 1GB memory. The testing data is from convenient stores and contains more than 2.4 million records. The computer computation time each month is less than 30 minutes because of efficient algorithm but the storage space requirement is enormous. The estimation of 2-year sales history occupies 40 GB of hard disk space. The estimating DSS is finished and implemented in December 2001. It started the estimation process since March 2002. Totally, 24 months of history sales data of convenience stores has been imported to the system. The estimation has been made for each item each month. Drilling down and summing up OLAP functions are also added to the DSS so users can query the estimation from item, classification, area, or living-zone point of views. The DSS is also built with web enabling capability so users can easily access the results through internet browsers as seen in Figure 7.

Although verification procedure has been carried out carefully to make sure the execution of the algorithm accurately, no public data exists to validate the result of estimation. The estimation result has been shown to the participants of the project including the convenient chain stores, supermarket chains, and hypermarket chains. In June 2002, a meeting is held among DISC, retailers and the manufacturers to show some estimation results from this system. The purpose of this meeting is also to validate the estimation results through manufacturers. The manufacturers all showed great interests in obtaining this estimation result mainly

because there is no other source to provide such census retailing information. It is the first time that the manufacturers have the opportunity to be able to gain some insight of the local market for each individual product. To show some impact, the sales of a famous tea drink (200 ml) reaches 200 millions of NT dollars (more than 6 millions US\$) alone last year in convenient stores market. To everyone's surprise, its biggest group of consumers is student since it showed the biggest sales in school zone. The estimation also shows that the market of tea drink is fierce competed among several large local manufacturers. With such valuable information, the manufacturers are willing to pay for this information but the scales and levels of services are still under negotiation.

The DSS for supermarkets and hypermarkets are also finished and implemented at the same time. However, the import of the sales information from these two types of retailers has not been completed until July 2002. The system is under testing and is expected to be on line at the end of this year. Because of the sensitivity and confidentiality of the sales data, it is prohibited to show the user interfaces and results of this estimation DSS here.

## 6. Conclusion

This study proposed an algorithm to estimate the market size of product with UPC in Taiwan based on the sampled sales information provided by retailer chains. By sampled sales information, it means that each retailer chain provides sales information from only a small portion of its retailing stores. Through certain public accessible data such number of stores by each chain etc, the sampled sales information can be transferred to the market size information of each item in Taiwan. A DSS is built based on this estimation algorithm and is implemented successfully. In the future, the estimation information can be further processed to provide more value-added information. One of the extensions will be to adopt some forecast models such as time series analysis and economic/environmental variables. From current estimation results, it is clear that zones, areas, and classifications of items all have impacts on sales. For example, sales of tea drink in school zone show very significant seasonal effect while sales of coffee on the other hand demonstrate no seasonal effect at all. In the future, different prediction models can be used for items in different classifications, zones, and areas.

## Reference

[1] Andreasen, A. R., "Backward Market Research," *Harvard Business Review*, 1985, pp. 176—182.

[2] Amaravadi, C. S., S. Samaddar, and S. Dutta, "Intelligent Marketing Information Systems: Computerized Intelligence for Marketing

Decisions Making," *Marketing Intelligence & Planning*, Vol. 13, No. 2, 1995, pp. 4—13.

[3] Berry, M. J. A. and G. S. Linoff, "Data Mining Techniques: For Marketing, Sales, and Customer Support," Wiley, 1997.

[4] Curry, D. J., "Single-Source Systems: Retail Management Present and Future," *Journal of Retailing*, 1989, pp. 1—20.

[5] Farnum, N.R. and L.W. Staton, "Quantitative Forecasting Methods," PWS-Kent, Boston, MA, 1989.

[6] Higby, M.A. and B. N. Farah, "The Status of Marketing Information Systems, Decision Support Systems and Expert Systems in the Marketing Function of U.S. Firms," *Information & Management*, 1991, Vol. 20, pp. 29—35.

[7] Li, E. Y., R. McLeod, Jr., and J. C. Rogers, "Marketing Information Systems in the Fortune 500 Companies: Past, Present, and Future," *Journal of Management Information Systems*, Summer 1993, Vol. 10, No. 1, pp. 165—192.

[8] Li, E. Y., R., "Marketing Information Systems in the Top U.S. Companies: A Longitudinal Analysis," *Information & Management*, Vol. 28, 1995, pp. 13—31.

[9] Li, E. Y., R., "Marketing Information Systems in Small Companies", *Information Resources Management Journal*, vol. 10, No. 1, 1997, pp.27-35.

[10] Li, E. Y., R. McLeod, Jr., and J. C. Rogers, "Marketing information systems in Fortune 500 companies," *Information & Management*, September, Vol. 38, 2001, pp.307-322.

[11] Morris, M. H., A. C. Burns, and R. A. Avila, "Computer Awareness and Usage by Industrial Marketers," *Industrial Marketing Management*, 1989, Vol. 18, pp. 223—232.

[12] Rapp, S. and T. L. Collins, "The New Direction in Advertising and Marketing Strategy," McGraw-Hill, New York, 1987.

[13] Schwedelson, R., "New Wave Database," *Direct Marketing*, 1998.

[14] Talvinen, J. M., "Information Systems in Marketing: Identifying Opportunities for New Applications," *European Journal of Marketing*, Vol. 29, No. 1, 1995, pp. 8—26.

[15] Talvinen, J. M. and T. Saarinen, "MkIS Support for the Marketing Management Process: Perceived Improvements for Marketing Management," *Marketing Intelligence & Planning*, 1995, Vol. 13, No. 1, pp. 18—27.

[16] Taylor, B. W., "Introduction to Management Science," Englewood Cliffs, N.J.: Prentice Hall, 1996.

[17] Wilson, J. H. and B. Keating, "Business Forecasting," Boston, MA: Irwin, 1990.

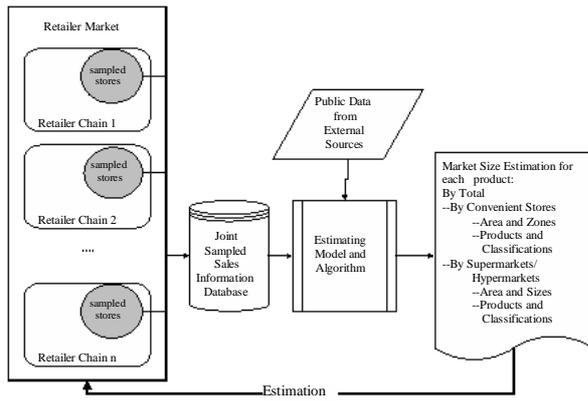


Figure 1: Problem of Estimating Sales

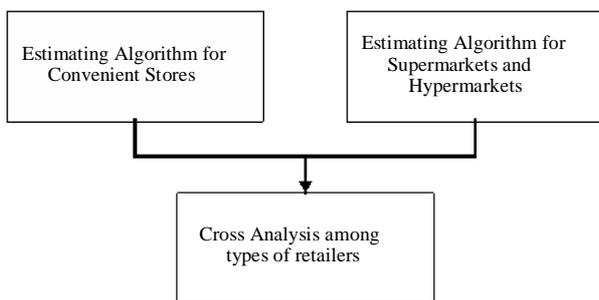


Figure 2: The Estimation Process

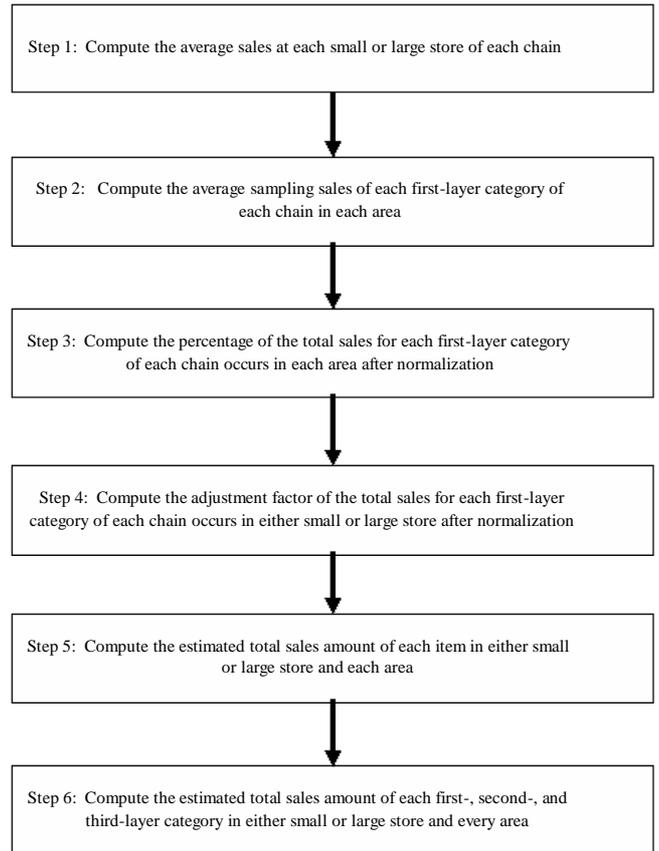


Figure 4: Algorithm for Supermarkets or Hypermarkets

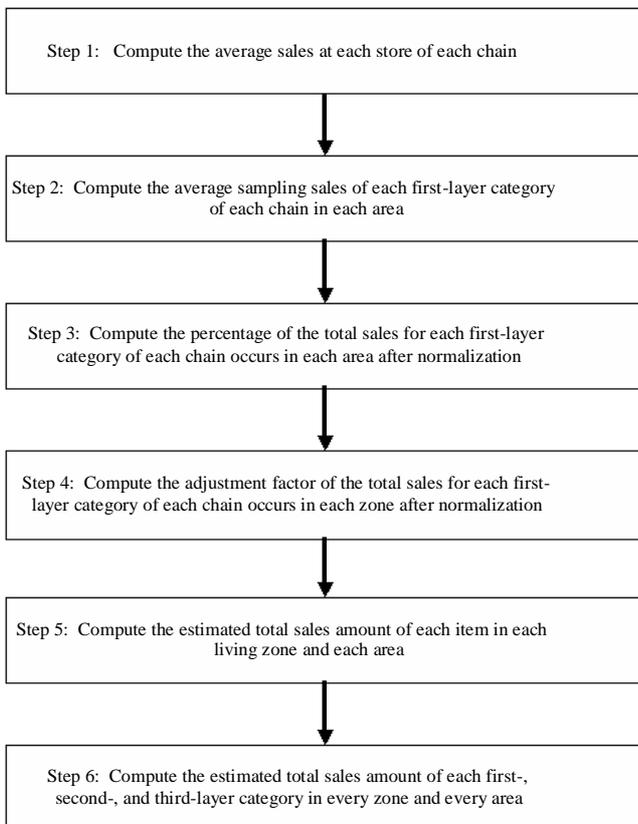


Figure 3: Algorithm for Convenient Stores

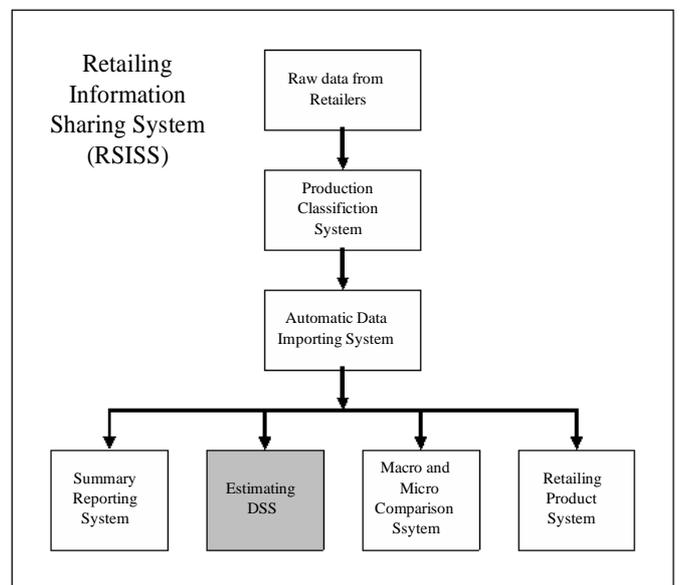


Figure 5: The Position of the Estimating DSS in RSISS

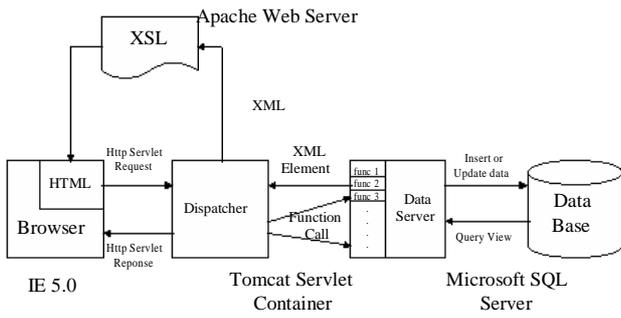


Figure 6: The Architecture of Servers for the Estimating DSS

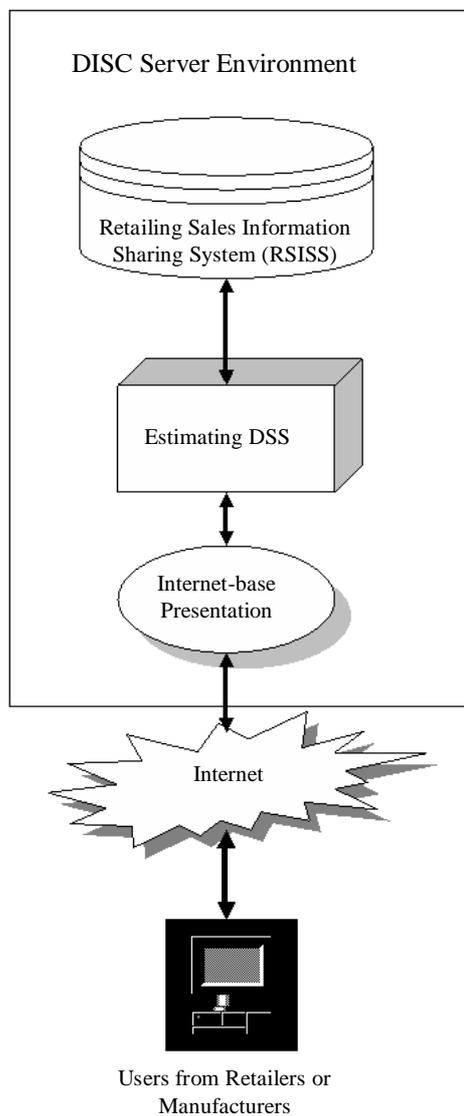


Figure 7: The environment of the Estimating DSS

# On the Accuracy of Judgments in the AHP

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## Abstract

Errors or inaccuracy always occurs when we use the Analytic Hierarchy Process to aid decision making. This paper shows the errors can be divided into two parts. One is called System Error and another is called Judgment Error. System Error is caused by the judgment ratio of pairwise compare matrix which must be taken from set of  $\{1/9, 1/8, \dots, 1, 2, \dots, 9\}$ . The Judgment Error is caused by human wrong judgment. The computational results in this paper demonstrate that the System Error may cause the confusable priority of the alternatives and a proposed method which increase the ratio accuracy can clear the priority of the alternatives.

Key Word: Decision Support, Analytic Hierarchy Process (AHP), Reversal Rank, System Error

## 1. Introduction

The Analytic Hierarchy Process (AHP) is a powerful decision support tools which aid decision makers in solving complex decision problems. It decomposes the real complex decision problems into several levels of hierarchies. The first level of the hierarchy is the goal of decision problem, the second and the lower levels are placed by many relevant criteria, subcriteria, and/or alternatives. Usually, the alternatives occupy the last level of the hierarchy and represent the goal to be accomplished. The decision maker assesses a pairwise comparison judgment matrix (PCJM(n)) for each level of hierarchy to establish local vectors of priorities for n criteria, subcriteria, and alternatives. The composite vector of priorities for decision alternatives is obtained by combining the local priority vectors associated with the criteria or subcriteria of all levels of the hierarchy.

How to get accurate priority of alternatives from the judgments given by decision maker is a important problem in decision making science [3]. In the Analytic Hierarchy Process (AHP), this problem is solved by getting the information of redundant judgments of a decision maker. According to the AHP theory, the decision maker is required to give  $n(n-1)/2$  pairwise judgments ratio for an n alternatives decision problem and only (n-1) judgments is necessary. The AHP method modifies the accuracy of judgments by using the  $n(n-1)/2$

- (n-1) redundant judgments [1]. But using the AHP makes at least two kinds of errors. One is called System Error (SE) and another is called Judgment Error (JE). SE is caused by the judgments ratio must be taken from the set  $= \{1/9, 1/8, \dots, 1, 2, \dots, 9\}$ . The JE is caused by human wrong judgment. Now we focus on the SE problems and propose how to clear the confusable priority which caused by SE.

When we use the AHP to aid in our decision making, the System Error is always caused since the judgment ratio must be taken from the set  $S1 = \{1/9, 1/8, \dots, 1, 2, \dots, 9\}$ . Therefore, the ratio is approximate to the real value. Here the real value of weight of alternatives is continuous, which is true in more application problems. The priority we obtain by using the AHP is also an approximation of the true priority. In our research, we try to find the difference between the computational priority and the real priority.

Triantaphyllou and Mann gave some relative research in this problem. He concluded that it is possible for some alternatives to have the same rank while in reality they are distinct [4]. In additionally, he demonstrated that it is possible alternatives which in reality are less important than others to appear to be more important after the AHP are used. In our present simulation, we confirm the Triantaphyllou and Mann's results and suggest a method to avoid reversal problem caused by SE.

## 2. Our Simulation Analysis

As assumption that the real weights of alternatives are continuity, the  $w_1, w_2, \dots, w_n$  are the real weight values of the n alternatives. We suppose that the decision maker knew the above real values and he would be able to construct a matrix with the real pairwise comparisons. This matrix is called Real Continuous Pairwise matrix (RCP). In RCP, each element,  $a_{ij}$  is obtained by the ratio  $w_i/w_j$ . Also, the judge would be able to determine the entry  $a_{ij}$  as close as possible  $w_i/w_j$  value taken from the set  $S1 = \{1/9, 1/8, \dots, 1, 2, \dots, 9\}$  when the AHP is used. Notice that this determination has a little bit difference with Triantaphyllou and Mann's. It is because the matrix is a reciprocal matrix. The minimal of  $|a_{ij} - w_i/w_j|$  is not same as that of  $|1/a_{ij} - w_j/w_i|$  when the  $w_i/w_j < 1$ . This matrix is called Closed Discrete Pairwise matrix (CDP).

Our simulation includes that randomly generate the real vector of the alternatives, construct the RCP and CDP, calculate the eigenvectors of RCP and CDP, then

compare the eigenvectors with the real vector. In generating the real vector, the ratio of largest against smallest value is less than 9 since the comparable axiom limited [1]. The eigenvectors of RCP and CDP are calculated by Power Method because it is suit for the simulation [2]. The comparison of the vectors just compare the rank of the vectors. That is, if the eigenvector of the CDP has the same rank with real vector, the Correct Sign (CS) is given. If the eigenvector of the CDP has rank changed for real vector rank, the Rank changed Sign (RS) is given. If some elements of eigenvector of the CDP have the same rank while in real vector they are distinct, the causing Equal elements Sign (ES) is given. Here is a number example which given in the Trantaphyllou and Mann's paper, but the result is not exact same as theirs because their calculation has some mistake.

Real vector : (0.1325 0.0890 0.5251 0.2533)

$$RCP = \begin{bmatrix} 1.0000 & 1.4888 & 0.2523 & 0.5231 \\ 0.6717 & 1.0000 & 0.1695 & 0.3514 \\ 3.9603 & 5.9000 & 1.0000 & 2.0730 \\ 1.9117 & 2.8461 & 0.4824 & 1.0000 \end{bmatrix}$$

Eigenvector of RCP : (0.1325 0.0890 0.5252 0.2533)

$$CDP = \begin{bmatrix} 1.0000 & 1.0000 & 0.2500 & 0.5000 \\ 1.0000 & 1.0000 & 0.1667 & 0.3333 \\ 4.0000 & 6.0000 & 1.0000 & 2.0000 \\ 2.0000 & 3.0000 & 0.5000 & 1.0000 \end{bmatrix}$$

Eigenvector of CDP: (0.1187 0.0970 0.5229 0.2614)

In this example, for CDP, the CS = 1, RS = 0 and ES =0.

Let us show another example:

Real vector : (0.0486 0.3551 0.2558 0.3406)

$$RCP = \begin{bmatrix} 1.0000 & 0.1368 & 0.1899 & 0.1426 \\ 7.3111 & 1.0000 & 1.3881 & 1.0426 \\ 5.2671 & 0.7204 & 1.0000 & 0.7511 \\ 7.0126 & 0.9592 & 1.3314 & 1.0000 \end{bmatrix}$$

Eigenvector of RCP : (0.0486 0.3551 0.2558 0.3406)

$$CDP = \begin{bmatrix} 1.0000 & 0.1429 & 0.2000 & 0.1429 \\ 7.0000 & 1.0000 & 1.0000 & 1.0000 \\ 5.0000 & 1.0000 & 1.0000 & 1.0000 \\ 7.0000 & 1.0000 & 1.0000 & 1.0000 \end{bmatrix}$$

Eigenvector of CDP : (0.0507 0.3249 0.2996 0.3249)

In this example, for CDP, the CS = 0, RS = 0 and ES =1.

From later example, we find the ES is caused by the approximation of ratio especially the ratio which equal to

1. That is, these alternatives have very close weight values. If we increase the accuracy of ratio of these weight values to 0.1, the eigenvector of CDP should present the correct rank. The following is the eigenvector of revised CDP:

$$CDP1 = \begin{bmatrix} 1.0000 & 0.1370 & 0.1887 & 0.1429 \\ 7.3000 & 1.0000 & 1.4000 & 1.0000 \\ 5.3000 & 0.7143 & 1.0000 & 0.7692 \\ 7.0000 & 1.0000 & 1.3000 & 1.0000 \end{bmatrix}$$

Eigenvector of CDP : (0.0485 0.3521 0.2573 0.3421)

In this example, for CDP1, the CS1 = 1, RS1 = 0 and ES1 =0. This revision which increase the accuracy is reasonable because we must increase the accuracy of measurement to determine the priority of the alternatives when present accuracy cannot identify difference between some alternatives.

Table 1 shows the results of our simulation for 1000 times and comparison results between real vector rank and eigenvector rank of CDP, CDP1, CDP2, CDP3 and CDP4 while eigenvector rank of RCP always same as the real vector rank.

Table 1. The Comparison Between Real Vector and eigenvector of CDP

Dimensio n	RS	ES	ES1	ES2	ES 3	ES4
15	0	928	287	23	2	0
14	0	920	271	20	2	0
13	0	922	243	16	1	0
12	0	903	223	10	0	0
11	0	891	231	12	1	0
10	0	856	191	10	0	0
9	0	819	175	12	1	1
8	0	775	161	16	1	0
7	0	740	130	10	1	1
6	0	679	121	7	0	0
5	0	624	113	0	1	0
4	0	517	89	5	0	0
3	0	486	65	2	0	0

### 3. Conclusions and discussions

In this paper, we do a preliminary simulation on the System Error which caused by the require the ratio taken from the set  $S1 = \{1/9, 1/8, \dots, 1, 2, \dots, 9\}$ . From the simulation, we find the System Error may make the rank of the CDP confusable especially when the number of the alternatives increased, but it doesn't make the reverse rank in the rank of the CDP. In order to clear the confusable of the rank of the alternatives, we propose a method which increases the accuracy of the pairwise ratio of those close alternatives. By using the revised method, the number of the confusable rank decrease very fast. Therefore, we can conclude that the revised method is an

effective method to solve the confusable rank of alternatives.

There are other problems relative to the System Error. In Triantaphyllou and Mann's paper, they found for the two level of a problem, the System Error causes the reversal problem. Therefore, the further research needed to do on this topic. These research include:

1. Can the revised method be used to solve the reversal problem which mentioned in Triantaphyllou and Mann's paper.
2. How to detect the Judgment Error? First, the model of judge has to be established. The model is decide by the probability of making wrong judgment when the real is  $r$ . Suppose the wrong ratio will be given in AHP is  $r, r \pm 1, r \pm 2, \dots, r \pm 9$ . As judge intent to get the correct ratio, the first corresponding probabilities are  $9P_{r \pm 9}, 8P_{r \pm 9}, \dots, 1P_{r \pm 9}$ . The  $P_{r \pm 9}$  is the probability which judge give the  $r \pm 9$  value. Then  $P_{r \pm 9} = 1/45$ .  $9P_{r \pm 9} = 20\%$ . That means judge will give correct ratio rat probability 20%. The second corresponding probabilities are  $2^8P_{r \pm 9}, 2^7P_{r \pm 9}, \dots, 2^0P_{r \pm 9}$ . Then  $P_{r \pm 9} = 1/511$ ,  $2^8P_{r \pm 9} = 256/511 = 50.098\%$ .
3. How to measure the System Error when we do not know the real weight of the alternatives?
4. The inconsistency of the PCJM is partly caused by system error and the judgment error. Which one causes the inconsistency more? It should be true that Judgment Error more than the System Error?
5. Can the System Error and the Judgment Error be used as another method to determine the consistency ratio?

## Reference

- [1] Saaty, T.L.: 1994, Fundamentals of Decision Making and Priority Theory with the Analytic Hierarchy Process, 197-223, RWS Publications, Pittsburgh, PA, USA.
- [2] Tummala, Rao and Ling, Hong: 1996 A Note on the Computation of the Mean Random Consistency Index of the Analytic Hierarchy Process (AHP), Theory and Decision. June 1998, Vol. 44, No. 3, pp. 221-230.
- [3] Sanchez, P.P, Soyer, R.: 1994 Information Concept and AHP. Proceeding of 3rd AHP Conference, P67-73.
- [4] Triantaphyllou, Evangelos and Mann, S. H.: 1994, A Computational Evaluation of the Original and Revised Analytic Hierarchy Process, Computers and engineering Vol 26, No. 3, pp 609-618

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- (7) Track area: Decision Support Systems and Intelligent Systems

# Reexamining the Benefits of Information Systems in Japanese Manufacturing Companies

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## Abstract

It is quite reasonable to presuppose that information systems provide various benefits to manufacturers. But we don't have much evidence on the benefits especially in Japanese manufacturing. In this paper we investigated the hypotheses presented by Matsui and Sato [6] [7] concerning the effects of information technologies and information systems upon manufacturing benefits with slightly different analytical approach and samples. We introduced more precise measure for implementation of information technologies and information systems, and divided the sample consisting of forty-six Japanese manufacturing companies into two sub-sample, world-class and random. The result of our analysis endorsed some of the propositions proved by Matsui and Sato [7], and provided new evidence to the hypotheses that utilization of statistical process control software improves product quality, implementation of computer-based production equipment control increases product-mix flexibility, and utilization of database for quality information and an increase in the percentage of external units electronically linked with the plant improve customer service. It also suggested additional hypotheses. Further, we discovered different relationships of information systems implementation with manufacturing benefits between world-class and randomly sampled companies.

## 1. Introduction

Market competition in manufacturing sectors is becoming fierce in these days. The globalization of economy expands market for manufacturing goods, but at the same time it enlarges the area of competition among manufacturers. One of the most important weapons for manufacturing firms is information technologies and information systems, which are hereafter abbreviated as IS. IS potentially gives many benefits and competitive advantages to manufacturers, if it is appropriately used. These benefits include reduction in manufacturing cost, decrease in inventories, overall lead-time reduction, improvement in on-time deliveries, increased product-mix flexibility, increased production-volume flexibility, reduced new product introduction time, improved customer service, increased level of cooperation with customers and suppliers, improved product differentiation, and improved product quality. These benefits become

critically dependent on the implementation of IS, although they are certainly affected by various factors except IS.

In this paper we intend to focus effects of IS upon these benefits in Japanese manufacturing plants. According to Matsui and Sato [7], appropriate implementation of production IS had strong impact upon these benefits in Japanese manufacturing companies. It also shows that the effect varied among IS employed. For example, implementation of computer-based production equipment control (CPEC) has strong impact on reduction of manufacturing cost (RMFC), but implementation of automated retrieval/storage systems (ATRS) has little impact on RMFC. Because the study used only one sample for Japanese manufacturers, and because there are few relevant studies, we investigate more about those propositions and extend above empirical research further to answer the following questions in this paper:

1. Did the implementation and experience of production IS contribute to a set of manufacturing benefits in Japan?
2. What kind of IS has more impact on each benefit in the Japanese manufacturing plants?
3. Did world-class companies enjoy IS benefit more than others in Japan?
4. Are propositions that Matsui and Sato [6] [7] presented robust enough?

## 2. Research Background

One of the most important weapons to compete against rivals in global manufacturing markets is application of IS. As Heizer and Render [2, p.272] described, "firms that know how to use technology find it an excellent vehicle for obtaining competitive advantage." Knowing how to apply and use IS to gain maximum benefit has been, therefore, a critical subject for most manufacturing companies for last decades.

However, we cannot find much research concerning IS benefits for Japanese manufacturing companies. Matsui and Sato [4] [5] [6] [7] proposed an analytical framework and research hypotheses concerning benefits of production information systems for manufacturing companies. Matsui and Sato [7] did an empirical research about IS benefits for Japanese manufacturing plants. It revealed that implementation of computer aided design (CAD), computer aided processes planning (CAPP), machine tools with computer or direct numerical control,

material requirements planning II (closed-loop MRP), computer-based production equipment control, utilization of statistical process control software, purchase orders sent to suppliers by electronic data interchange, and high percentage of external units (including suppliers, distributors, company plants, banks, etc.) that were electronically linked with the plant have contributed to Japanese manufacturing firms.

The results endorsed some of their hypotheses about benefits of each information technology (IT), but failed to prove others. The hypotheses are summarized in Table 9 below, where P's and S's in the cells stand for primary and secondary effects of each IT, respectively. The merits of their research were the relatively high fitness of the model to their data, and the potential for international comparison partly made in Matsui and Sato [4] [6] among others. On the other, it has certain limitations that were the paucity of samples available, and some incongruence to their hypotheses.

### 3. Hypotheses

As discussed in the above research as well as others including Hammer and Champy [1], Schroeder and Flynn [8] etc., IS is supposed to have positive impact on manufacturing performance. For example, CAD is supposed to contribute shortening design phase of new product development, improve design quality and help automation of production process. These reduce cost for new product introduction. CAE seems to improve reliability of parts and finished goods as well as hasten the new product development process. CAPP has a main effect on the reduction in cycle time, which in turn reduces manufacturing cost. The effect of LAN could be widespread from the automatic control of machine tools and robotics through various flows of production information to attain CIM.

However, the level or degree of IS impact may be differing among plants, companies, industries, and countries. One reason that Matsui and Sato [7] failed to endorse their hypotheses completely might come from the difference among sub-samples. For example, high performance companies may employ IT wiser than other companies. As a result, if we divide the Japanese sample into world-class plants and others, world-class plants may reveal stronger relationships between IT implementation and the benefits. If we employ more samples to investigate the difference, we may be able to find different or stronger relationships between IS and manufacturing benefits. Therefore, our research hypotheses will be expressed as follows:

H1: World-class manufacturers (WCM) show stronger relationships between implementation of IT and the benefits on manufacturing than other firms.

H2: More hypotheses suggested by Matsui and Sato [6] [7] are proved if we limit samples to WCM.

We shall study these hypotheses, resting on our empirical data for the Japanese manufacturing companies.

## 4. Data

### 4.1 Data Collection Procedure

We have conducted a set of questionnaire surveys on Japanese manufacturing plants. We selected plants from machinery, electrical & electronics, and automobile manufacturers located in Japan, visited those plants and asked their cooperation to collect data. We left a set of questionnaires in the plants and recovered them back later.

Table 1  
Abbreviations of IS used in this study

Abbreviation	Explanation
CAD	Implementation of computer aided design
CAE	Implementation of computer aided engineering
CAPP	Implementation of computer aided processes planning
LAN	Introduction of local area networks linking design and engineering stations
CDNC	Implementation of machine tools with computer or direct numerical control
FMS	Implementation of flexible manufacturing systems
ATRS	Implementation of automated retrieval/storage systems
MRP1	Implementation of material requirements planning I (type one MRP)
MRP2	Implementation of material requirements planning II (closed-loop MRP)
JITS	Utilization of just-in-time software
SIMT	Utilization of simulation tools
SPCS	Utilization of statistical process control software

Our Japanese sample accounts for forty-six plants. Among them, thirty-two plants are subjectively judged to be world-class and the rest are randomly sampled from machinery, electrical & electronics, and automobile manufacturers. In any plant, twenty-six individuals across levels responded to fifteen types of questionnaires that partly share the same questions. The respondents included plant manager, plant superintendent, plant research coordinator, plant accountant, human resource manager, inventory/purchasing manager, information systems manager, production control manager, process engineer, quality manager, supervisors and direct labor. Plant-level data were calculated as an average value of all the valid responses at the plant for each measurement scale.

### 4.2 Measures of IS Implementation

This study deals with eighteen information technology variables concerning CAD, CAE, CAPP, NC machine tools, FMS, computer-based production equipment

control, automated retrieval/storage, MRP I and II, simulation tools, JIT software, SPC software, database for quality information, LAN, and EDI. Twelve independent variables measure implementation of these IS. They are listed in Table 1 with abbreviations. In order to identify which IS had been utilized in the plant, the IS manager was asked the year when the plant had implemented each IS listed in Table 1. We calculated the usage length from implementation or experience of each IS by subtracting the year from 2000, and regarded it as a measure of IS implementation. If a plant had not implemented certain IS, we assigned a zero to the variable. These measures have more information on the implementation of IS than the dummy variables employed in Matsui and Sato [4] [5] [6] [7].

Table 2  
Additional Scales of IS Implementation

Abbreviation	Explanation
PCOR	Percentage of customer orders received via electronic data interchange (%)
PPOS	Percentage of purchase orders sent to suppliers by electronic data interchange (%)
PSPL	Percentage of suppliers linked to the plant via electronic data interchange (%)
PELL	Percentage of external units electronically linked with the plant (%)
CPEC	Implementation of computer-based production equipment control
DBQI	Utilization of database for quality information

We appended six more measures of IS implementation in Table 2. Four variables, customer orders received via EDI (PCOR), purchase orders sent to suppliers by EDI (PPOS), suppliers linked to the plant via EDI (PSPL), and external units (including suppliers, distributors, company plants, banks, etc.) electronically linked with the plant (PELL), were measured in percentage. PSPL and PELL were directly asked to the IS manager. The inventory/purchasing manager also answered PCOR and PPOS. These variables range from 0 to 100 as percentage. The other two variables, implementation of computer-based production equipment control (CPEC) and utilization of database for quality information (DBQI), are dummy variables and take only two values, either 1 if implemented or 0 otherwise.

As a result, we have three types of data, i.e., year, dummy, and percentage. Because the range and distribution are different among variables, we normalize those variables, which can delete the size effect and make easy direct comparisons of the data. We will use the normalized variables as scales of IS implementation in the subsequent analysis.

#### 4.3 Measures of Benefits

Manufacturing benefits of IS implementation are listed in Table 3. They are designed as five-point Likert scales (1=Strongly disagree, 2=Disagree, 3=Neither agree nor disagree, 4=Agree, 5=Strongly agree), and added to our questionnaire. These questions are asked to an IS manager, a production manager, and a plant superintendent of each plant. They assessed subjectively whether the benefits could be directly attributed to the implementation of particular information system in the plant on a five-point Likert scale. We calculated average values of the responses from these three persons to construct manufacturing benefit measures at the plant level.

Table 3  
Abbreviations of IS Benefits Measured

Abbreviation	Explanation
RMFC	Reduction in manufacturing cost
DINV	Decrease in inventories
OLTR	Overall lead time reduction
IOTD	Improvement in on-time deliveries
IPMF	Increased product-mix flexibility
IPVF	Increased production-volume flexibility
RNPI	flexibility
ICSV	Reduced new product introduction time
ILCC	Improved customer service
ILCS	Increased level of cooperation with customers
IPDF	Increased level of cooperation with suppliers
IPQL	Improved product differentiation
	Improved product quality

#### 5. Research Method

We investigate our hypotheses about the effect of implementation of IS on manufacturing benefits by correlation analysis, using the above data. Because all data are real measures, Pearson's true product-moment correlation is appropriate for this analysis. We consider manufacturing benefits as dependent variables, and IS implementation as independent variables. We compare results of correlation analysis among the following cases:

1. Use data for all forty-six plants
2. Use data for thirty-two world-class plants
3. Use data for fourteen randomly sampled plants

Generally speaking, the smaller the sample size is, the higher the correlation coefficient becomes to attain certain significance level of rejecting the null hypothesis that the correlation is zero. Therefore, we compare the levels of significance as well as the absolute values of the coefficients.

We did not employ regression analysis that tried to explain variation of manufacturing benefits with a set of IS implementation variables because of high correlation among independent variables.

Table 4  
Comparison of Correlation Coefficients (1)

Benefits IS	RMFC			DINV	OLTR	
	ALL	WCM	OTHER	ALL	ALL	WCM
CAE			0.657*			
CAPP	0.315*	0.356*				0.402*
LAN					0.341*	
CDNC	0.351*					
MRP2			-0.564*			
JITS					0.370*	
SPCS		0.392*				
CPEC	0.361*	0.451+		0.311*		
DBQI	0.424+	0.535+			-0.505+	
PCOR	0.357*		0.777*			
PSPL					0.337*	

+ significant at the 1% level by one-tailed test  
\* significant at the 5% level by one-tailed test

Table 5  
Comparison of Correlation Coefficients (2)

Benefits IS	IOTD			IPMF		IPVF	
	ALL	WCM	OTHER	ALL	WCM	ALL	WCM
CAE			0.670+				
CAPP		0.407*					
LAN				0.328*			
FMS				0.353*			
ATRS				0.427+	0.425*		
JITS				0.561+	0.575+	0.350*	
SIMT			0.561*	0.336*		0.370*	
SPCS				0.334*		0.343*	0.355*
CPEC					0.390*		
DBQI			0.578*				
PCOR	0.371*						
PSPL	0.421+	0.487+					

+ significant at the 1% level by one-tailed test  
\* significant at the 5% level by one-tailed test

## 6. Results of Analysis

### 6.1 Interpretation of Negative Coefficients

Tables 4 to 7 compare the results of correlation analysis. They show only significant results. We find that some of IS have significant negative effects on manufacturing benefits, although we did not originally assumed significant and negative correlation coefficients. Hence, we need to discuss about them first of all. Implementation of MRP II significantly correlates with the increase in manufacturing cost in non-WCM plants, shown in Table 4. We may be able to interpret this finding as MRP II is so expensive and complex for non-WCM plants to use that the introduction could complicate their processes and increase their costs for production. The

correlation coefficient between DBQI (database for quality information) and OLTR (overall lead time reduction) is also significantly negative for the whole sample. We can interpret the result as the existence of tradeoff between utilization of quality information database and delivery performance.

Table 6  
Comparison of Correlation Coefficients (3)

Benefits IS	RNPI			ICSV		ILCC	
	ALL	WCM	OTHER	ALL	WCM	ALL	WCM
CAD	0.376*						
CAE	0.362*		0.699+				
CAPP							0.433*
LAN	0.368*						
FMS	0.321*			0.320*			
ATRS	0.329*	0.438*		0.297*	0.375*		
MRP2	0.363*	0.405*					
JITS	0.448+	0.485+					
SIMT	0.340*						
CPEC							0.356*
DBQI				0.423+	0.468+	0.325*	0.373*
PELL				-0.332*	-0.373*	-0.406+	-0.462+

+ significant at the 1% level by one-tailed test  
\* significant at the 5% level by one-tailed test

Table 7  
Comparison of Correlation Coefficients (4)

Benefits IS	ILCS			IPDF		IPQL	
	ALL	WCM	OTHER	ALL	WCM	ALL	WCM
CAE			0.647*				
ATRS	0.354*	0.365*		0.301*	0.383*		
SIMT	0.294*						
SPCS							0.376*
CPEC	0.477+	0.431*					
DBQI						0.301*	

+ significant at the 1% level by one-tailed test  
\* significant at the 5% level by one-tailed test

We also find significant negative correlation coefficients of PELL (percentage of external units that were electronically linked with the plant) with ICSV (improved customer service) and ILCC (increased level of cooperation with customers) for the whole sample and WCM sample. The results reveal that the usage of electronic link to external units decreases customer service and cooperation with customers. Most customers for the plants are not consumers but wholesalers or other manufacturing companies. Usually the number of customers is considerably limited, and both customers and plants prefer face-to-face contacts rather than electronic linkages.

We tend to presuppose that introduction of IS *always*

provide benefits in *all aspects* in a plant. But our results imply that this is not true. External links may be good in many cases, but they are not necessarily for customer service and cooperation with customers.

## 6.2 Do the relationships become stronger if we limit samples?

After we calculate correlation coefficients and compare the significance, we can identify five patterns of significance in correlations for three samples. They are summarized in Table 8. In Table 8, “significant only when ...” means that a significant coefficient appears only one of three columns (corresponding to samples) for each dependent variable. “More significant when ...” represents significant coefficients appear two of three columns for each dependent variable. We actually compared the whole sample with WCM sample or non-WCM sample. The last pattern, “Significant regardless sample limitation,” means significant coefficients appear in all columns for each dependent variable. We counted the number of these cases in Table 4 through Table 7.

Generally speaking, the larger sample size becomes, the easier it is to get significant coefficients. Therefore, the number of significant cases tends to be large for the

whole sample than for the WCM sample, and in turn for the WCM sample than for the non-WCM sample. The distribution of the number of significant cases in Table 8 is intuitively reasonable.

If a case is in pattern 1, then the relationship is consistent but not so robust. If a case is in pattern 2, then it means it is specific to WCM plants only. It may be the

Table 8  
Patterns of Significance

	Pattern	Sample size	Number of significance
1	Significant only when we use all data	46	19
2	Significant only when we limit to WCM data	32	8
3	Significant only when we exclude WCM data	14	6
4	More significant when we limit to WCM data	32, 46	18
5	More significant when we exclude WCM data	14, 46	2
6	Significant regardless sample limitation	46, 32, 14	0

Table 9  
Matching hypotheses and two empirical results

IS	Benefits of PIS	RMFC	DINV	OLTR	IOTD	IPMF	IPVF	RNPI	ICSV	ILCC	ILCS	IPDF	IPQL
CAD					P			P	*	*		*P	
CAE					P			P				P	P
CAPP		*4		*2P	*2				S	*2			
LAN				P		*			S				
CNC/DNC		*P											P
FMS		P		P		P	*		S				P
Automated R/S			P	P	P	*4P	*	*4	*4S		4	*4	*
MRP I		P	P			P	*		*				
MRP II		*P	P			P		4					
JIT software		P	P			*4		*4		*	*	*	
SPC software		*2					4		P				2P
Equipment control		*4		P		2P	P		*S	2	4		
Quality database		4					*		4S	4			*P
Orders received by EDI				P	P				S	*			
Orders sent by EDI		*		P	P		*	*	*S	*	*	*	*
Suppliers linked by EDI				P	*2P				S				
Units electronically linked		*		P	P			P	4S	*4P	P	P	

1. Hypotheses by Matsui and Sato [7] P: primary effect S: secondary effect
2. \* Significant results by Matsui and Sato [7]
3. Significant Relationship in this paper 2: pattern 2 4: pattern 4

secret source of excellence in the WCM plants. Or, it might represent a kind of hurdle a manufacturing plant must overcome to be world class. This pattern supports our hypothesis H1. If a case is in pattern 3, it is a strong relationship we find for non-WCM plants only. It may be a false application of IS to the manufacturers. If a case is in pattern 4, then the relationship is consistent but it appear more explicitly in WCM plants. These are cases that our hypothesis H2 implies. If a case is in pattern 5, we cannot find the correlation coefficient is not high for the WCM sample, and there is certainly significant relationship for non-WCM plants, as compared to the whole sample. It would be specific to non-WCM plants. If a case is in pattern 6, the relationship is consistent and robust regardless of plant type (either WCM or not). Unfortunately we cannot find this pattern from Table 4 through Table 7.

Now we go for the examination of our hypotheses, H1 and H2. We compare the cases in pattern 2 and pattern 4 with hypothesized effects presented in Matsui and Sato [6] [7] in Table 9. “P” stands for a hypothesized relationship as a primary effect. “S” means the relationship is hypothesized as a secondary effect. “\*” indicates that the relationship was significant at 5% level in Matsui and Sato [7]. “2” and “4” mean the relationship is classified into pattern 2 and pattern 4, respectively, in Table 8.

Table 10 counts the number of cases according to the combination of marks (\*, 2, 4, P and S) in Table 9. The combination takes seven different forms or types. For instance, the hypothesized relationships that were not proved by Matsui and Sato [7] but acknowledged by this correlation analysis are to be categorized into type 3. These relationships potentially include four different combinations of marks in Table 9 as follows: 2P, 4P, 2S, and 4S. Actually the table includes the entries of 2P and 4S only.

According to these tables, we can induce some important results concerning the hypotheses, H1 and H2. Firstly, CPEC contributes IPMF, that is, implementation of computer-based production equipment control increase product-mix flexibility. This sounds natural, but the point is that this relationship is applicable only to WCM plants. In fact, we find a reverse relationship for non-WCM plants, although it is not significant. Implementation of computer-based production equipment control might decrease product-mix flexibility for non-WCM plants. This associates the old CIM model, which was punctuated by a series of failures and results that fell below expectations.

Secondly, DBQI contributes ICSV, that is, utilization of database for quality information improved customer service. This also sounds natural and associates quality assurance activities by WCM plants. This relationship is labeled “4S” in table 9. Matsui and Sato [7] hypothesized the relationship as secondary, and Table 6 shows it is significant for the whole sample and highly significant for the WCM sample (p-value is 0.007). On the other hand, the non-WCM sample shows negative relationship between DBQI and ICSV, but the correlation coefficient is

almost zero.

Thirdly, PELL effects ICSV. But the relationship is negative, as we have already discussed in the previous section.

Finally, SPCS contributes to IPQL, i.e., utilization of statistical process control software improved product quality. This is marked as “2P” in Table 9. Matsui and Sato [6] [7] hypothesized the relationship as primary, and this relationship is strongly supported for the WCM sample only. Certainly, the relationship is negative for the non-WCM sample, although not significant. At least utilization of statistical process control software doesn’t seem to improve product quality of non-WCM plants. Unless they use statistical process control software appropriately, it won’t contribute to quality performance. This could be the case for non-WCM plants.

Table 10  
Summary of Congruence Between Hypotheses and Results

	Type	Mark	Number
1	Proved by Matsui and Sato [7]	*P or *S	6
2	Proved by this analysis	2P or 4S	4
3	Proved by both empirical studies	*2P, *4P, or *4S	5
4	Not hypothesized but both empirical studies agree	*2 or *4	4
5	Hypothesized but unproved	P or S	40
6	Appear only in Matsui and Sato [7]	*	21
7	Appear only in this analysis	2 or 4	7

The marks appear in table 9.

## 7. Conclusions

In this paper we investigated hypotheses set by Matsui and Sato [6] [7], and conducted an additional empirical analysis with different approach and samples. We can answer to the questions that we addressed in the introductory section of this paper as follows:

1. Did the implementation and experience of production IS contribute to a set of manufacturing benefits in Japan?  
Our analysis gives additional support for the proposition.
2. What kind of IS has more impact on each benefit in Japanese manufacturing plants?  
Table 4 through Table 7 summarize significant relationships between IS implementation and manufacturing benefits.
3. Did world-class plants enjoy IS benefit more than others in Japan?  
As table 8 shows, world-class companies proclaim more significant relationships between certain IS implementation and benefits than others.
4. Are propositions that Matsui and Sato [6] [7] presented

robust enough?

Some of them are endorsed by our analysis as shown in table 9 and they seem robust to us. There are still, however, others which remain unproved.

We took up a set of hypotheses that Matsui and Sato [6] [7] had raised, and verified them through different analytical approach and different samples. Human beings don't know the truth of the universe. In order to approach the truth, we need to accumulate empirical research hopefully from different points of view along with different analytical tools and different samples to verify our hypotheses, and then refine our hypotheses if accumulated empirical results are not consistent with them. Straub [9] recommended multi trait multi method (MTMM) as an empirical research approach, and Mahmood and Soon [3] applied the method to IS. Although this research is not MTMM, precisely speaking, it investigates a set of hypotheses presented by Matsui and Sato [6] [7] from a different method. Regression results by Matsui and Sato [4] [5] [6] [7] tend to be inconsistent depending on samples employed in the analysis. This is especially true if we don't have enough sample size, as was the case of Matsui and Sato [7]. As a result, true hypotheses might be rejected with the analysis, or false hypotheses might be accepted. We tried to verify the findings of Matsui and Sato [7].

In fact, our analysis supports five hypotheses proved by Matsui and Sato [7], but fails to endorse six hypotheses proved by the paper according to Table 10. We successfully find evidences for four additional hypotheses that Matsui and Sato [7] hypothesized but failed to support. The most important finding is that WCM sample insisted the significance of some relationships, but non-WCM sample implied reverse relationships. These suggest critical differences between WCM plants and others. Besides, we can support four more relationships that Matsui and Sato [7] revealed but had not hypothesized. Because these relationships seem robust, we may be able to establish them as new hypotheses.

We need to repeat more empirical analyses to confirm the robustness of these hypotheses, verify and refine them hopefully from different points of view with different analytical approaches, and establish new set of hypotheses. There are also some weaknesses in our study.

Firstly, samples used are not large enough (see Table 8). Secondly, many samples are the same as those of Matsui and Sato [7]. Thirdly, the method we employ to establish our measures needs to be examined more. Empirical results might be affected by what kind of measures we used in the study, and this caveat is also applicable to our study. At last we need to examine the relationships that non-WCM plants enjoy but WCM plants do not. These are pattern 3 and pattern 5 in Table 8. We need to investigate why WCM plants fail to enjoy these benefits from IS. These will be next research topics for us.

## References

- [1] Hammer, M. & Champy, J. *Reengineering the Corporation*, HarperBusiness, 1993.
- [2] Heizer J. & Render, B. *Operations Management*, Prentice Hall, 1999.
- [3] Mahmood, M.A. & Soon, S.K. "A Comprehensive Model for Measuring the Potential Impact of Information Technology on Organizational Strategic Variables," *Decision Sciences*, 1991, 22(4), 869-897.
- [4] Matsui, Y. & Sato, O. "An International Comparison Study on the Benefits of Production Information Systems," in Gupta, O.K. & Seethamraju, R. (eds.), *Information Technology and Operations Management: Relationships and Synergies, Proceedings of the Third International Conference on Operations and Quantitative Management*, Tata McGraw-Hill, 2000, 156-166.
- [5] Matsui, Y. & Sato, O. "An Inter-industrial Comparison Study on the Benefits of Production Information Systems," *Proceedings of the 5th Pacific Asia Conference on Information Systems (PACIS2001)*, 2001, 197-211.
- [6] Matsui, Y. and Sato, O. "A Comparative Analysis on the Benefits of Production Information Systems," *Proceedings of the 32nd Annual Meeting of Decision Sciences Institute*, 2001, 687-689.
- [7] Matsui, Y. & Sato, O. "An Empirical Analysis on the Benefits of Production Information Systems for Japanese Manufacturing Companies," *Proceedings of the First International Conference on Electronic Business*, 2001, 180-182.
- [8] Schroeder, R.G. & Flynn, B.B. (eds.) *High Performance Manufacturing: Global Perspectives*, John Wiley & Sons, 2001.
- [9] Straub, D.W. "Validating Instruments in MIS Research," *MIS Quarterly*, 1989, 13(2), 147-169.

# An Empirical Study of Business Strategy and Performance

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## Abstract

This study examines the association of corporate strategy with multiply criteria of financial performance across national boundaries. Using data over a four-year period from Korea, the United States, and Japan, the study presents a multidimensional definition of corporate strategy. These dimensions are then modeled as predictors of three corporate performance criteria. The results show that corporate strategy explains a significant portion of financial performance. In addition, corporate strategy relates differently to different performance criteria within and across the three countries.

## 1. Introduction

This paper examines the association of corporate strategy with financial performance across national boundaries. Throughout the paper corporate strategy is viewed as the plan a firm follows in pursuit of its long-term goals. A viable corporate strategy defines the scope of a company's business and the portfolio of products it must offer. In turn, this definition guides a company's allocation of resources, with the aim of building and maintaining a competitive advantage by developing or acquiring essential skills. These capabilities are functionally-based and emerge from a firm's expertise and excellence in different areas. When the firm possesses such skills, it can build a strong market position.

Evidence suggests that corporate strategy is a major predictor of financial performance within an industry or across economic sectors in one country and across borders. Yet, despite the ever growing interest in comparative corporate practices, only few empirical studies have been conducted to date on the relationship of corporate strategy and financial performance. A possible reason for this paucity of empirical research is the difficulty in collecting data on corporate strategy across countries because of the differences in accounting systems and variations in reporting practices. Not surprisingly, then, the bulk of past research in the area has emphasized such industrialized countries as the United States, Canada, England, West Germany, France, and Italy. While insightful, these studies' findings may not apply to other non-western countries that are at different stages of economic growth or espouse non-western cultural value systems. Moreover, as other regions of the world gain economic power, there is a need to test existing theories of corporate strategy in these new contexts. Findings from

such comparative studies can be used to revise or construct theories that guide corporate strategic choices under different national economic structures.

## 2. Objective

This study examines the association between corporate strategy and financial performance in three countries: Japan, Korea and the United States. To achieve this goal, the study advances a multidimensional definition of corporate strategy and outlines the predicted relationships between the components of corporate strategy and financial performance. We will follow this by presenting the sample, methods, and results of a comparative empirical that uses data from 150 manufacturing companies from each of the three countries, for four years. Finally, the nature and implications of our findings for managerial action and future research are discussed in the last section of the paper.

## 3. Corporate Strategy

A strategy is best viewed as a stream of decisions made by a company over a finite time horizon. In formulating corporate strategy, executives must define the scope of the firm's business and sources of its competencies and capabilities.

A starting point in mapping corporate strategy is the delineation of the breadth of the firm's domain. The issue revolves around deciding the extent to which a firm will specialize in one industry or compete in multiple industries. This decision is based on the firm's track record, resources, forecast of industry trends, and preferences of its senior executives.

Once the breadth of the domain (scope) of business has been determined, the next step involves developing the sources of a firm's competitive competence. This is achieved by examining potential sources of excellence in functional areas such as marketing, finance, and production/operations. Other functions can also provide a basis for building a competitive advantage that enables the firm to position itself in its chosen markets.

There are many sources within each functional area that can be used to build and sustain a competitive advantage. As suggested in literature, different components of corporate strategy can determine corporate financial performance. The magnitude and direction of these effects depend on the performance criterion used. These effects vary from one country to another.

### 3.1 Breadth and Performance

The breadth of a company's concept of business is usually clarified in the extent of its diversification; i.e., the degree to which a firm pursues different lines of business. Some companies are committed to one, core business while others actively pursue different businesses in related or unrelated fields.

The relationship between corporate diversification and financial performance has been the subject of considerable discussion in the literature. However, the results of past empirical research have been contradictory. Some studies suggest that diversification does not always result in improved financial performance. Benefits - such as improved performance - will result only from the effective implementation of diversification activities and by integrating acquired firms within the business portfolio. Without this integration, diversification may result in poor financial performance.

In this comparative study we expect diversification to be associated with high corporate financial performance for several reasons. Diversification enhances a firm's market power, thus enabling it to control its suppliers, buyers, and resources. Diversification also enables companies to use excess cash and reduce business risk. Diversification helps a firm to shield itself against business and economic adversity by maintaining a balance portfolio. Moreover, when carefully carried out, diversification can take the firm into lucrative fields and high growth industries, thus improving its performance. These observations lead to the study's first hypotheses (H1): H1: Diversification is positively associated with corporate financial performance.

Of the three countries examined in this study, Korea remains the least diversified in its manufacturing sector. It was observed that Korean manufacturing firms stress "business groups," a collection of vertically and horizontally related enterprises that support one another. A business group, then, reduces the need for extensive diversification activities among its members since many of them function as both suppliers and buyers of each other's goods. Not surprisingly, the statistical results reported in the literature suggest that group-affiliated firms show superior economic performance than those firms that do not belong to a "business group."

The above discussion suggests that significant differences exist in the level of diversification among American, Japanese and Korean companies. This suggests that the association between diversification and company performance (postulated in H1) will vary from one country to another.

### 3.2 Marketing Activities and Performance

Marketing strategies and practices can enhance a firm's ability to serve its markets or penetrate new segments. There is a growing body of literature centered on the role of strategic marketing in determining company performance. The literature suggests that a firm possess-

ing expertise in marketing is well-poised to make important inroads into its domestic and foreign markets.

Two variables are of interest in this study because they determine a firm's ability to reach its customers: advertising intensity and export levels. Both variables are predicted to be positively associated with corporate financial performance. The rationale for these predicted associations is discussed below.

#### 3.2.1 Advertising Intensity

Research suggests that a firm must be close to its customers while differentiating itself from its rivals to achieve effective financial performance. Advertising enables a firm to attract new customers or increase penetration of existing segments, in domestic and international markets. This means that a corporation must invest heavily in its advertising activities to create a substantial competitive advantage. This advantage is reflected in a strong, positive corporate reputation in the minds of customers, thus creating loyalty to products and brands. A strong, positive reputation also encourages potential customers to "switch," from using competitors' products to using the company's own brands. For these reasons, advertising can be the source of barriers (thus protecting a company's market position) and income by attracting new customers. Consequently, advertising is expected to be associated with high corporate financial performance. For companies whose products are diverse (as is true of the corporations studied here), investment in advertising can be highly profitable. An increase in advertising intensity, defined as the level of that activity's expenditure divided by company sales, leads to higher profits.

It appears American, Japanese and Korean companies view advertising spending as crucial to financial success in their own home markets and overseas as well. This leads to the following hypothesis: H2a: Advertising intensity is associated positively with corporate financial performance.

#### 3.2.2 Export Activities

Engaging in exporting provides a firm with several benefits beyond serving solely a domestic market. Exporting is expected to bring more profits when the foreign market is growing or has very few substitutes, or when a company's capacity exceeds the needs of its local market. And, during a domestic business downturn, exports generally tend to help steady financial performance and sometimes can even increase profits during a domestic recession. Selling abroad also helps to gain economy in production at home-economies which can improve a firm's competitive position. For many companies, export business frequently provides the difference between a profit and a loss.

Because of the many benefits of exporting, countries are increasingly active in promoting this strategy. For instance, Japan, Korea, and the United States have adopted several measures to promote their exports. However, the success of the strategies adopted by these coun-

tries varies considerably. These very startling differences reflect currency fluctuations and different levels of competence among companies in the two countries in producing and marketing in international markets. Statistics and case studies also suggest that Japanese and Korean firms continue to succeed far more frequently in their export efforts than American companies, significantly raising the deficit in the US balance of trade. No matter the sources of success and failure in exporting, companies in the three countries are increasingly active in pursuing new international markets while strengthening their hold on existing niches in those markets. This emphasis stems from a belief that exporting is a major source of growth in revenue and profitability. Thus: H2b: A higher level of export activities is positively associated with company financial performance.

### 3.3 Financial Structure and Performance

Traditionally, financial structure is an important dimension of corporate strategy. Its importance stems from the fact that the ability of a firm to acquire financial resources plays a crucial role in determining its success in the marketplace. Two variables, in particular, are emphasized in this study as indicators of corporate success in developing appropriate financial strategies: leverage position and credit efficiency.

#### 3.3.1 Leverage

This variable refers to the portion of a firm's capital secured through long-term debts; it is operationalized as the debt-to-equity ratio. Several studies have reported a negative association between debt leverage and firm profitability. Higher corporate debt loads tend to depress profits because they increase the burden of servicing the debt. In addition, financial risk increases as this ratio rises because of the increased cost of servicing debt. Moreover, it has been compellingly argued that increased leverage frequently reduces risk-taking by the firm's senior executives. This line of reasoning suggests that benefits from leverage (access to financial resources from external sources) may be far lower than the risks associated with it (conservatism and slowness in corporate activities) which, ultimately, leads to lower profits. Therefore, H3a: Increased leverage is negatively associated with corporate financial performance.

#### 3.3.2 Credit Activities

This variable refers to the ability of a firm to collect its accounts receivables efficiently. Failure to manage credit activities dilutes a firm's financial resources and reduces its cash position. The ability of a firm to collect its accounts is usually measured by the average period it takes the company to accomplish this task. The shorter the period, the more efficient the firm and the higher its performance. Efficient management of credit activities reduces reliance on leverage for financing corporate activities. This helps to counteract the negative side effects of

high leverage, discussed above. Thus: H3b: Efficiency of credit is associated positively with corporate financial performance.

### 3.4 Operations Activities

The value of manufacturing is becoming increasingly recognized as a competitive tool in global markets. Simply stated, manufacturing can make or break an organization. If well managed, manufacturing can be a potent source of competitive advantage and superior corporate performance. A comprehensive review of the literature on operations strategy suggests that three variables are particularly crucial: capital intensity, inventory efficiency, and employee efficiency.

#### 3.4.1 Capital Intensity

As a component of corporate strategy, this variable represents a firm's long-term commitment to building its technological base and upgrading its productive capacity. Capital intensity is defined as total corporate assets divided by sales. Such investments lead to improved production processes that reduce cost or eliminate waste, thus enhancing company performance.

Capital intensity has been the subject of much research in industrial economics and international business. Interest in this variable stems from the recognition of possible substitution of labor and capital in manufacturing. Typically, the question centers on the optimal combination of these two variables (labor and capital), with other factors of production, that lead to an optimal cost structure.

We expect a positive association between capital expenditure and corporate financial resources. This prediction is based on the assumption that capital expenditure, which may dilute short-term resources, will pay off over time. This positive view of the relationship between capital intensity and corporate performance is supported by several classic empirical studies. Past studies and this discussion suggest the following hypothesis: H4a: Capital intensity is positively associated with corporate financial profitability.

#### 3.4.2 Inventory Efficiency

The literature highlights the importance of effectively managing inventory to reduce waste and ensure sufficient supplies for corporate operations. Efficient inventory control is an integral component of an effective operations strategy. As a result, new approaches ensure efficient inventory management. Just-in-time (JIT) techniques and other methods make it possible to plan logistics prudently to improve corporate performance. The popularity of these and similar innovative techniques attests to a growing appreciation by American, Japanese and Korean companies of the implications of inventory management for their profitability and smooth process of manufacturing. Thus: H4b: Inventory efficiency is positively associated with corporate financial performance.

### 3.4.3 Labor Productivity

It has been suggested that labor productivity, measured as the per capita, value added or sales contribution, provides an important indicator of the success of operations strategy. Labor productivity is a major source of corporate performance; the higher this productivity, the higher the corporate performance. This argument rests on a valid assumption: for productivity improvements to occur, successful systems of managing the manufacturing process should exist. Toward this end, American companies have initiated several efforts to reform their managerial practices with the goal of improving labor productivity, as a means of improving their corporate performance. Thus: H4c: Labor productivity is associated positively with corporate financial performance.

## 4. The Moderating Effect of National Boundaries

The literature suggests that the impact of strategy variables on performance varies from one country to another, and even within the same country at different points in time. Therefore, the preceding hypotheses (H1 through H4) should be viewed as contingent (dependent) on country membership.

There are several reasons for expecting the associations to vary by country. First, as argued earlier, the countries vary in their reliance on diversification, use of leverage, capital structure, extent of their export activities, and investment in marketing efforts (e.g., advertising intensity). These differences are expected reflected in different coefficients between individual components of corporate strategy as "predictors" of company performance. Second, companies in the three countries compete in markets that differ significantly in their structure. Japanese and Korean companies are well protected from any massive foreign entry in many segments of their home manufacturing sectors. Such protection enhances the profitability of these firms. American companies do not necessarily enjoy such protected "home base" advantage. Third, the literature suggests that American companies are managed quite differently from Japanese and Korean companies. While differences in the strategic process among companies in different countries are not the focus of this study, we cannot help but wonder if these differences translate into specific sources of competence across countries. Fourth, as mentioned, there are important differences among firms in the three countries in the levels of labor productivity. These differences can be the source of significant cost and price differences in international markets, thus affecting levels of company performance in the three countries differently. These differences, as well as those suggested above in discussing individual hypotheses (H1 through H4), lead to a final hypothesis. H5: Corporate strategy-financial performance associations will vary from one country to another.

## 5. Method

### 5.1 Samples and Data Collection

The samples used in this study consisted of the leading 150 publicly listed manufacturing corporations from the United States, Japan and Korea. These countries were selected because of the different stages of their economic development and the variations in the structure of their national economies. Another reason for their selection is the wide recognition of the important role of the three countries in world trade.

To ensure as valid comparisons as feasible, firms were matched by their sales volume, measured in US\$ million. They were chosen from among the leading 500 companies in each country. The data covered the four-year period of 1996-1999.

Data for American companies were collected from COMPU-STAT, annual reports and 10-K Reports. For Japanese corporations, data were gathered from annual reports of listed companies by the Japanese Chamber of Commerce. Finally, annual reports of listed companies by the Korean Chamber of Commerce were the primary sources of data for South Korean corporations.

### 5.2 Measures

#### 5.2.1 Financial Performance

Corporate performance is multifaceted and, thus, no single measure can fully capture its domain. In addition, preferences for financial performance criteria may vary from one country to another. For example, some Korean firms have opted to forego making significant profits for years to ensure international expansion and growth. Consequently, to gain accurate results and safeguard against the problems associated with any single performance measure, this study employed three indices of major financial performance measures for the 1996-1999 period: return on sales (ROS), return on investment (ROI), and return on assets (ROA), as follows:

∅ Return on Sales = Operating Profit/Sales

∅ Return on Investment = Operating Profit/Investment

∅ Return on Assets = Operating Profit/Assets

#### 5.2.2 Breadth

This study was concerned with the diversification of organization; i.e., reliance on development and specialization of product. Therefore, diversification was operationalized in terms of product specialization. This measure followed the widely-acknowledged entropy measure which emphasized three key elements of a firm's diversification operations: the number of product segments in which the firm operated; the distribution of the firm's total revenues across the product segments; and the degree of relatedness among the various product segments. Accordingly, diversification was operationalized

Accordingly, diversification was operationalized in terms of the ratio of the sales of the major product to the total sales of the firm, as follows:

Diversification =  $1 - (SP_i/TS_i)$  where:  $SP_i$  is the sales volume of the major product and  $TS_i$  is the total sales of the firm in a given year. While this measure is widely used in the literature, it must be noted that it is difficult to identify Korean and Japanese companies' major product lines because of the business groups that dominate those two countries' economies. To safeguard against this problem, multiple secondary sources were consulted to cross-validate the data.

### 5.2.3 Marketing Activities

Two ratios were constructed, using the formula below.

1. Advertising Intensity = Corporate Advertising Expenditure/Corporate Sales Volume
2. Export Level = Export Volume/Corporate Sales Volume

### 5.2.4 Financial Structure

Leverage and credit efficiency were measured as follows:

1. Leverage = Long-term Debt/Equity
2. Credit = (Account Receivables/Total Sales Volume) X 365

### 5.2.5 Operations Strategy

Three formulae were used to gauge operations strategy, as follows:

1. Capital intensity = Fixed Assets/Total Assets
2. Inventory efficiency = Inventory (book value)/Sales
3. Labor productivity = Corporate Sales Volume/Number of Full-Time Employees

All measures were calculated using the four-year averages. This 4-year average allows us to eliminate extremes in the data and year-to-year variations that might obscure trends. Further, we believe that this time frame is necessary to observe the results of corporate international activities. Shorter time frames do not afford us such an opportunity.

## 6. Analysis and Results

### 6.1 Overview

Data for each country were analyzed separately to avoid problems associated with translating currencies using volatile exchange rates. Separate analyses also controlled for variations in accounting conventions among Japanese, Korean and American companies.

As a first step, Pearson's simple correlations among the independent variable set (i.e., components of corporate strategy) for each country were examined to determine lack of multi-collinearity. In the Japanese sample,

correlations ranged between -.44 to .23. For the Korean sample, correlations ranged between .02 and .37. For the American corporations, intercorrelations ranged between -.01 and .34. These ranges suggested the independence of predictor variables. Further, we tested for multicollinearity using the procedures outlined in Neter et al. (1989). These analyses suggested that multicollinearity was not a serious issue in the current data.

Multiple regression analysis served as the primary technique for testing hypotheses 1 through 4.

To test the study's fifth and final hypothesis, the Chow test was employed to find whether the results of regression analyses (9 runs = 3 regressions X 3 dependent variables each) were statistically different.

### 6.2 Japanese Companies

Table 1 shows that the three regression analyses for the Japanese sample were statistically significant (all at  $p < .05$ ). The explanatory power ( $R^2$ ) of the regression models varied:  $R^2$  was .19 for ROS, .31 for ROA, and .41 for ROI. These results supported the importance of corporate strategy variables as correlates of corporate financial performance.

	Performance Criteria		
	ROS	ROA	ROI
<u>Domain Breadth</u>			
Diversification	-.02	-.11	.04
<u>Marketing Strategy</u>			
Advertising Intensity	.16*	-.12	-.12**
Export Level	-.08	-.03	-.08
<u>Financial Strategy</u>			
Leverage	-.02	-.02	-.06
Credit Policy	.09	-.23**	-.39***
<u>Operational Strategy</u>			
Inventory Efficiency	-.01	-.46***	.68***
Employee Productivity	-.32***	-.06	.07
Capital Intensity	-.09	-.36***	-.16**
Constant	.91	.42	.19
$R^2$	.19	.31	.41
F	4.15***	8.21***	40.51***

\*  $p < .05$   
 \*\*  $p < .01$   
 \*\*\*  $p < .001$

Table 1 also showed that different dimensions of corporate strategy exhibited different associations with financial performance. This supported the literature suggestion to use multiple performance indicators. For instance, Table 1 shows that advertising intensity was related to ROS positively but employee productivity was negatively associated with this measure. Note that inventory efficiency was associated positively with ROA and ROI whereas a high credit policy and capital intensity

were associated with lower ROA and ROI. Finally, advertising intensity was significantly associated with ROI.

### 6.3 Korean Companies

The Korean sample exhibited different patterns of associations between corporate strategy and financial performance criteria from those observed earlier in the Japanese sample, at least in three aspects (see Table 2). First, Korean firms with higher levels of diversification had higher returns compared to other companies selected for this study. The beta value of the diversification ratio had a strong positive association with the three company financial performance measures: ROS, ROA and ROI.

	Performance Criteria		
	ROS	ROA	ROI
<u>Domain Breadth</u>			
Diversification	1.13***	.53***	.99***
<u>Marketing Strategy</u>			
Advertising Intensity	-.66***	-.28**	-.58***
Export Level	-.06	.02	-.02
<u>Financial Strategy</u>			
Leverage	.02	.03	-.10
Credit Policy	.04	-.11	.03
<u>Operational Strategy</u>			
Inventory Efficiency	-.05	.11	-.16
Employee Productivity	.06	-.13	.27
Capital Intensity	.09	.04	.14
Constant	-.01	1.15	.00
R <sup>2</sup>	.69	.14	.47
F	39.72***	3.12**	15.91***

\* p < .05  
\*\* p < .01  
\*\*\* p < .001

Second, the intensity of advertising expenses was negatively related to the three corporate financial performance criteria. In other words, the more money that Korean companies spent on advertising relative to their sales volume, the less return on sales, assets, and investment.

Finally, these dimensions of corporate strategy were fairly powerful in explaining ROS and ROI ( $R^2 = .69$  and  $.47$ ). ROA was primarily affected by other factors beyond those included in this study since the  $R^2$  is equal to  $.14$ . Such low  $R^2$  is quite common in many studies of competitive strategy even when the number of predictor variables is very large. Clearly, corporate strategy is one of many factors that influence financial performance.

### 6.4 US Companies

The three regression models for the American sample were significant (all at  $p < .05$ ), with  $R^2$  ranging from  $.21$  to  $.41$ , as shown in Table 3. These  $R^2$  were smaller than

those observed in the Japanese and Korean samples. The results for the American sample are presented in Table 3. ROS, ROA, and ROI were associated positively with two variables: advertising intensity and inventory efficiency. ROS was also associated positively with credit policy and capital intensity. Clearly, the pattern of relationships in the American sample was different from the preceding results of both the Japanese and Korean corporations.

	Performance Criteria		
	ROS	ROA	ROI
<u>Domain Breadth</u>			
Diversification	.05	.03	-.01
<u>Marketing Strategy</u>			
Advertising Intensity	.16*	.14*	.13*
Export Level	.07	.11	.09
<u>Financial Strategy</u>			
Leverage	-.02	-.12	.05
Credit Policy	.17*	.02	.00
<u>Operational Strategy</u>			
Inventory Efficiency	.37***	.53***	.62***
Employee Productivity	.07	.10	.01
Capital Intensity	.02*	.05	-.00
Constant	-.03	-.01	-2.21
R <sup>2</sup>	.21	.35	.41
F	4.94***	10.05***	12.89***

\* p < .05  
\*\* p < .01  
\*\*\* p < .001

### 6.5 Comparisons of the Results Across Three Nations

This section will compare and contrast the results of the study's first four hypotheses (H1 through H4). Clearly, the results vary from one country to the next, as summarized in Table 4, which presents a comparison of the three samples.

#### 6.5.1 Breadth (H1)

Diversification strategy is not associated with higher corporate performance for Japanese or American companies, but is significant in Korean firms. Therefore, the general hypothesis of the positive relationship between diversification and corporate performance is not fully supported in this study. A possible explanation for the lack of success of the diversification strategy of Japanese and American firms is that the companies in this sample are, for the most part, multinational enterprises - their product lines are broad. This raises the possibility that diversification in these firms might have taken them away from their core businesses. If this situation is true, diversification is tantamount to wasted resources.

Another possible reason for lack of significant association between diversification and company financial performance

formance emerges from the literature: most diversification efforts fail to enhance company performance and productivity. This failure stems from lack of experience by senior managers in new lines of business, lack of synergy between new and existing units, and differences in organizational cultures among new and old units in the portfolio. Finally, there is the possibility that some diversification efforts pay off handsomely but it takes a considerably longer period (than the period examined here) to do.

Table 4  
The relationship between corporate strategy and performance: Regression of three samples

	Performance Criteria *		
	Japan	Korea	US
<u>Domain Breadth</u>			
Diversification	NS	S (+)	NS
<u>Marketing Strategy</u>			
Advertising Intensity	XD	S (+)	S (+)
Export Level	NS	NS	NS
<u>Financial Strategy</u>			
Leverage	NS	NS	NS
Credit Policy	M (-)	NS	M (-)
<u>Operational Strategy</u>			
Inventory Efficiency	M (+)	NS	M (-)
Employee Productivity	L (-)	NS	L (-)
Capital Intensity	M (-)	NS	M (-)

\*For each sample

- S = Consistently significant using the three performance criteria
- M = Significant on two performance criteria
- L = Significant on only one criterion
- XD = Mixed support
- NS = Not significant
- + = Positive relationship
- = Negative relationship

### 6.5.2 Marketing Strategy (H2)

Surprisingly, expansion via exporting does not seem to bring a higher return for firms in the three nations examined here. This may be the result of the similar size of the firms in this study and their international experience. Exporting is the first step in entering the global market. Once they have established their export business, companies tend to take advantage of other international activities such as sourcing, offshore production, and direct investment.

The above explanation gains credence as evidence on the export behavior of American, Japanese and Korean firms is reviewed. It appears that Japanese, Korean and Pacific Rim countries have gained prominence in international trade by encouraging their small companies to be active in exporting. So, the benefits for larger companies may be limited whereas smaller firms gain considerably from international commerce.

In contrast to exporting, increasing advertising expenditure brings different financial results depending on

where the firm is located. For American firms, a higher advertising expenditure relative to sales is associated with better financial performance. On the other hand, if Korean firms spend more on advertising, their payoff is negative. For the Japanese firms, an increase in advertising expenditure brings mixed results, either improving or decreasing corporate financial performance. These results may reflect the level of the stage of economic development. Developed countries tend to spend more on advertising than developing and newly industrialized nations. While developed countries employ advertising to stimulate consumer demand, in other nations - where supplies of consumer goods are limited - advertising is an important selling tool to diversify demand from supply-constrained products to those which are plentiful. This is why an increase in advertising intensity has led to negative financial returns in Korea in the current study. For Japanese firms, the impact of advertising on financial performance is inconclusive, although Japan has reached the developed country status. A possible reason for such a mixed signal is that the Japanese market structure is based on imperfect competition between networks of controlled or closed channels of distribution. Consumers have limited choices of what is available in stores.

### 6.5.3 Financial Strategy (H3)

The results show that financial leverage is not associated with high corporate financial performance. An explanation is that companies (especially in the United States) are sometimes leveraged beyond their optimal level. Therefore, the cost of capital may offset any benefits from their leverage position. Interestingly, the more efficient an American or Japanese firm is in managing the credit it provides, the poorer is its financial performance. An explanation is that the impact of efficiency in managing credit may vary from one line of business to another. This means that the total efficiency index should be "decomposed" to examine the effect of its different components on financial performance. Another, and perhaps, more compelling explanation is that most companies offer credit terms and are generally efficient in managing their accounts receivables; this means that in today's competitive markets the efficient management of credit is required to do business but insufficient on its own merit to improve corporate performance.

### 6.5.4 Operational Strategy (H4)

For Korean firms, none of the measures under the operations strategy correlate significantly with the three financial performance criteria. For Japanese and American firms, the results are different. Inventory efficiency is positively related to the measures of financial performance; employee productivity is negatively associated with the financial performance; and capital intensity is negatively associated with the financial performance. Japanese firms have mastered the craft of operating inventory efficiently while American firms have imitated Japanese practices to increase their competitiveness. The

achievements of firms in these two countries have led to a lower level of inventory in relation to their sales volume. For Korean firms, inventory efficiency has been a less crucial factor to their competitiveness because of their low labor costs, reliance on small enterprise, and their use of many Japanese manufacturing practices.

On the surface, the negative relationship between employee productivity and corporate financial performance for Japanese and American firms is perplexing. Increasing sales per employee does not lead to better financial performance. This result can be explained by using the Leontief paradox. It suggests that developed countries' competitiveness depends on their production using skilled labor which causes exports to have a high labor intensity. Growth opportunities in the global market for firms in developed countries such as Japan and the United States require the use of high-skilled labor. This causes the employee productivity measure (sales volume divided by the number of employees) to be inversely associated with corporate financial performance.

Conversely, firms in newly-industrialized nations like Korea are facing a process of transition to move away from producing less low-tech to more high-tech items. That is probably why the relationship between employee productivity and financial performance is not significant.

One possible reason for a negative relationship between capital intensity and corporate financial performance is that Japanese and American firms rival each other for the position of the global economic leader. Investing in fixed assets to increase future productivity is one way to achieve a leadership status at the expense of short-term financial performance. Therefore, hypotheses H4a-c are partially supported.

#### 6.5.5 Moderating Influence of National Boundaries (H5)

The above discussion of cross-country differences and the statistical results support the fifth hypothesis (H5); the relationship between corporate strategy and financial performance differs in strength and magnitude from one country to another. This was confirmed using the Chow test, where seven of the nine regression runs (3 countries X 3 dependent variables) were statistically significant at  $p < .05$ . This suggested that the regression equations reflected very different situations and exhibited different structures.

The different results for each country suggest that theories of corporate strategic behavior need to be grounded in a thorough understanding of the national economy and culture. That is, universalistic assertions should be replaced with a well-crafted contingency model of organizational strategy. This message is consistent with the thrust of Michael E. Porter's (1990) work, as well as the conclusions reached by Alfred Chandler (1990). Using very different research designs and methods, both Chandler and Porter reach essentially the same conclusion: countries employ very different strategies to establish their lead in particular industries. These strategies build on the unique features of the domestic econ-

omy, national character and resource advantage. This implies that American, Japanese and Korean firms would employ very different strategies in asserting their competitive lead in international markets. Companies in these countries have expanded internationally at very different points in time, taking advantage of the distinct skills and competencies they developed in their home base or acquired through international trade. The point is: a theory of international competitiveness would benefit greatly from reviewing existing evidence and then postulating specific country-by-country hypotheses depending on the nature of the national economy and its stage of evolution.

## 7. Conclusions and Suggestions

This study has examined the relationship between corporate strategy and financial performance in three countries. As we expected, components of corporate strategy are correlated differently with different financial performance criteria within and across the three countries. That is, the relative significance and magnitude of the component of strategy have varied according to the criteria used and the country under consideration. Diversification emerges as the key strategy for Korean corporations in their effort to increase financial performance. For American firms, and to a certain extent Japanese firms, advertising is the major correlate of financial performance.

Future research on the topic would benefit from using different measures of corporate strategy variables. For instance, an alternative or more detailed measure of the diversification, financial, marketing and operations components may yield very different results from those found in this study.

Another useful study would be to look at the complete life-cycle of overseas corporate strategy. Although most of our hypotheses were partially supported by the results, the data provided only a snapshot of the corporate strategies under consideration. Strategy is drawn from a series of decision making. Better parallels can be drawn if comparisons are made at similar points in the corporate histories under examination. It would be unrealistic to expect the companies of different nations to employ the same strategies at the same time. Therefore, longitudinal research designs would allow a thorough evaluation of the effect of corporate strategy on performance.

A third possibility for future studies is to examine the impact of strategy on corporate performance by industry types. Although insignificant in this study, other studies suggest that different industries exhibit distinct characteristics in Korea, Japan, and the United States. These characteristics can explain possible differences in corporate performance.

This study highlights the importance of corporate strategy for understanding financial performance. The nine regression performance equations are statistically significant ( $p < .05$ ). Moreover, the results show that the efficacy of different strategy dimensions varies across countries. While the findings for particular dimensions are not consistent with theory-based predictions, they

only highlight the need for more theory building in this area and for large scale empirical studies to gain a better appreciation of the full ramifications of corporate strategy for company performance. We hope that this paper and its results encourage other researchers to test its findings or provide alternative frameworks that will enrich the field.

## References

- [1] Barney, J. "The resource-based model of the firm: Origins, implications, and prospects," *Journal of Management*, 1991, 17(1), 97- 98.
- [2] Chandler, A. *Scale and scope*. Cambridge, MA: Harvard University Press, 1990.
- [3] Chowdhury, A. "M & A mania: Tokyo Raiders turn to new Europe," *Asian Finance*, 1990, 16(5), 18-19.
- [4] De Castro, J.O. & Chrisman, J.J. "Order of market entry, competitive strategy, and financial performance," *Journal of Business Research*, 1995, 33(2), 165-177.
- [5] Dollar, D. & Sokoloff, K. "Patterns of productivity growth in South Korean manufacturing industries, 1963-1979", *Journal of Development Economics*, 1990, 33(2), 309-327.
- [6] Grant, R.M. *Contemporary strategy analysis*. New York, NY: Basil Blackwell, 1991.
- [7] Hax, A.C. & Majluf, N.S. *The strategy concepts & process*. Englewood Cliffs, NJ: Prentice-Hall, 1991.
- [8] Hodock, C.L. "Strategies behind the winners and losers," *Journal of Business Strategy*, 1990, 11(5), 4-7.
- [9] Hoskisson, R.E., Hitt, M. & Hill, C.W. "Managerial risk taking in diversified firms: An evolutionary perspective," *Organizational Science*, 1991, 2(2), 296-315.
- [10] Jain, S.C. *International marketing management*. Boston, MA: PWS-Kent Publishing, 1990.
- [11] Katz, J.P., Zarzeski, M.T., & Hall, H.J. "The impact of strategy, industry, and culture on forecasting the performance of global competitors: A strategic perspective," *Journal of Business Strategies*, 2000, 17(2), 119-143.
- [12] Lee, J. & Blevins, D.E. "Profitability and sales growth in industrialized versus newly industrialized countries," *Management International Review*, 1990, 30(1), 87-100.
- [13] Lehn, K. & Makhija, A.K. "EVA & MVA: As performance measures and signals for strategic change," *Strategy & Leadership*, 1996, 24(3), 34-38.
- [14] Levine, D.I. "Participation, productivity, and the firm's environment," *California Management Review*, 1990, 32(4), 86-100.
- [15] Lieberman, M.B., Lau, L.J. & Williams, M.D. "Firm-level productivity and management influence: A comparison of U.S. and Japanese automobile producers," *Management Science*, 1990, 36(10), 1193-1215.
- [16] McGahan, A. M. "Competition, strategy, and business performance," *California Management Review*, 1999, 41(3), 74-101.
- [17] Miller, R. "Profiting in the Pacific rim," *Target Marketing*, 1990, 13(3), 26-28.
- [18] Mintzberg, H. "The design school: Reconsidering the basic premises of strategic management," *Strategic Management Journal*, 1990, 11, 171-196.
- [19] Oster, S. M. *Modern competitive analysis*. New York, NY: Oxford University Press, 1990.
- [20] Pelham, A.M., "Influence of environment, strategy, and market orientation on performance in small manufacturing firms," *Journal of Business Research*, 1999, 45(1), 33-46.
- [21] Porter, M.E. *The competitive advantage of nations*. New York, NY: Free Press, 1990.
- [22] Remolona, E.M. "Understanding international differences in leverage trends," *Federal Reserve Bank of New York Quarterly Review*, 1990, 15(1), 31-42.
- [23] Schmenner, R.W. & Rho, B.H. "An international comparison of factory productivity," *International Journal of Operations & Production Management*, 1990, 10(4), 16-31.
- [24] Stimpert, J.L. & Duhaime, I.M. "Seeing the big picture: The influence of industry, diversification, and business strategy on performance," *Academy of Management Journal*, 1997, 40(3), 560-583.
- [25] Umezawa, M. "Japan's advertising boom-globalization holds the key to the future," *Tokyo Business Today*, 1990, 58(8), 22-23.
- [26] Zahra, S.A. & Garvis, D.M. "International corporate entrepreneurship and firm performance: The moderating effect of international environmental hostility," *Journal of Business Venturing*, 2000, 15(5/6), 469-492.

# An Empirical Study of Business Strategy and Performance

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## Abstract

This study examines the association of corporate strategy with multiply criteria of financial performance across national boundaries. Using data over a four-year period from Korea, the United States, and Japan, the study presents a multidimensional definition of corporate strategy. These dimensions are then modeled as predictors of three corporate performance criteria. The results show that corporate strategy explains a significant portion of financial performance. In addition, corporate strategy relates differently to different performance criteria within and across the three countries.

## 1. Introduction

This paper examines the association of corporate strategy with financial performance across national boundaries. Throughout the paper corporate strategy is viewed as the plan a firm follows in pursuit of its long-term goals. A viable corporate strategy defines the scope of a company's business and the portfolio of products it must offer. In turn, this definition guides a company's allocation of resources, with the aim of building and maintaining a competitive advantage by developing or acquiring essential skills. These capabilities are functionally-based and emerge from a firm's expertise and excellence in different areas. When the firm possesses such skills, it can build a strong market position.

Evidence suggests that corporate strategy is a major predictor of financial performance within an industry or across economic sectors in one country and across borders. Yet, despite the ever growing interest in comparative corporate practices, only few empirical studies have been conducted to date on the relationship of corporate strategy and financial performance. A possible reason for this paucity of empirical research is the difficulty in collecting data on corporate strategy across countries because of the differences in accounting systems and variations in reporting practices. Not surprisingly, then, the bulk of past research in the area has emphasized such industrialized countries as the United States, Canada, England, West Germany, France, and Italy. While insightful, these studies' findings may not apply to other non-western countries that are at different stages of economic growth or espouse non-western cultural value systems. Moreover, as other regions of the world gain economic power, there is a need to test existing theories of corporate strategy in these new contexts. Findings from

such comparative studies can be used to revise or construct theories that guide corporate strategic choices under different national economic structures.

## 2. Objective

This study examines the association between corporate strategy and financial performance in three countries: Japan, Korea and the United States. To achieve this goal, the study advances a multidimensional definition of corporate strategy and outlines the predicted relationships between the components of corporate strategy and financial performance. We will follow this by presenting the sample, methods, and results of a comparative empirical that uses data from 150 manufacturing companies from each of the three countries, for four years. Finally, the nature and implications of our findings for managerial action and future research are discussed in the last section of the paper.

## 3. Corporate Strategy

A strategy is best viewed as a stream of decisions made by a company over a finite time horizon. In formulating corporate strategy, executives must define the scope of the firm's business and sources of its competencies and capabilities.

A starting point in mapping corporate strategy is the delineation of the breadth of the firm's domain. The issue revolves around deciding the extent to which a firm will specialize in one industry or compete in multiple industries. This decision is based on the firm's track record, resources, forecast of industry trends, and preferences of its senior executives.

Once the breadth of the domain (scope) of business has been determined, the next step involves developing the sources of a firm's competitive competence. This is achieved by examining potential sources of excellence in functional areas such as marketing, finance, and production/operations. Other functions can also provide a basis for building a competitive advantage that enables the firm to position itself in its chosen markets.

There are many sources within each functional area that can be used to build and sustain a competitive advantage. As suggested in literature, different components of corporate strategy can determine corporate financial performance. The magnitude and direction of these effects depend on the performance criterion used. These effects vary from one country to another.

### 3.1 Breadth and Performance

The breadth of a company's concept of business is usually clarified in the extent of its diversification; i.e., the degree to which a firm pursues different lines of business. Some companies are committed to one, core business while others actively pursue different businesses in related or unrelated fields.

The relationship between corporate diversification and financial performance has been the subject of considerable discussion in the literature. However, the results of past empirical research have been contradictory. Some studies suggest that diversification does not always result in improved financial performance. Benefits - such as improved performance - will result only from the effective implementation of diversification activities and by integrating acquired firms within the business portfolio. Without this integration, diversification may result in poor financial performance.

In this comparative study we expect diversification to be associated with high corporate financial performance for several reasons. Diversification enhances a firm's market power, thus enabling it to control its suppliers, buyers, and resources. Diversification also enables companies to use excess cash and reduce business risk. Diversification helps a firm to shield itself against business and economic adversity by maintaining a balance portfolio. Moreover, when carefully carried out, diversification can take the firm into lucrative fields and high growth industries, thus improving its performance. These observations lead to the study's first hypotheses (H1): H1: Diversification is positively associated with corporate financial performance.

Of the three countries examined in this study, Korea remains the least diversified in its manufacturing sector. It was observed that Korean manufacturing firms stress "business groups," a collection of vertically and horizontally related enterprises that support one another. A business group, then, reduces the need for extensive diversification activities among its members since many of them function as both suppliers and buyers of each other's goods. Not surprisingly, the statistical results reported in the literature suggest that group-affiliated firms show superior economic performance than those firms that do not belong to a "business group."

The above discussion suggests that significant differences exist in the level of diversification among American, Japanese and Korean companies. This suggests that the association between diversification and company performance (postulated in H1) will vary from one country to another.

### 3.2 Marketing Activities and Performance

Marketing strategies and practices can enhance a firm's ability to serve its markets or penetrate new segments. There is a growing body of literature centered on the role of strategic marketing in determining company performance. The literature suggests that a firm possess-

ing expertise in marketing is well-poised to make important inroads into its domestic and foreign markets.

Two variables are of interest in this study because they determine a firm's ability to reach its customers: advertising intensity and export levels. Both variables are predicted to be positively associated with corporate financial performance. The rationale for these predicted associations is discussed below.

#### 3.2.1 Advertising Intensity

Research suggests that a firm must be close to its customers while differentiating itself from its rivals to achieve effective financial performance. Advertising enables a firm to attract new customers or increase penetration of existing segments, in domestic and international markets. This means that a corporation must invest heavily in its advertising activities to create a substantial competitive advantage. This advantage is reflected in a strong, positive corporate reputation in the minds of customers, thus creating loyalty to products and brands. A strong, positive reputation also encourages potential customers to "switch," from using competitors' products to using the company's own brands. For these reasons, advertising can be the source of barriers (thus protecting a company's market position) and income by attracting new customers. Consequently, advertising is expected to be associated with high corporate financial performance. For companies whose products are diverse (as is true of the corporations studied here), investment in advertising can be highly profitable. An increase in advertising intensity, defined as the level of that activity's expenditure divided by company sales, leads to higher profits.

It appears American, Japanese and Korean companies view advertising spending as crucial to financial success in their own home markets and overseas as well. This leads to the following hypothesis: H2a: Advertising intensity is associated positively with corporate financial performance.

#### 3.2.2 Export Activities

Engaging in exporting provides a firm with several benefits beyond serving solely a domestic market. Exporting is expected to bring more profits when the foreign market is growing or has very few substitutes, or when a company's capacity exceeds the needs of its local market. And, during a domestic business downturn, exports generally tend to help steady financial performance and sometimes can even increase profits during a domestic recession. Selling abroad also helps to gain economy in production at home-economies which can improve a firm's competitive position. For many companies, export business frequently provides the difference between a profit and a loss.

Because of the many benefits of exporting, countries are increasingly active in promoting this strategy. For instance, Japan, Korea, and the United States have adopted several measures to promote their exports. However, the success of the strategies adopted by these coun-

tries varies considerably. These very startling differences reflect currency fluctuations and different levels of competence among companies in the two countries in producing and marketing in international markets. Statistics and case studies also suggest that Japanese and Korean firms continue to succeed far more frequently in their export efforts than American companies, significantly raising the deficit in the US balance of trade. No matter the sources of success and failure in exporting, companies in the three countries are increasingly active in pursuing new international markets while strengthening their hold on existing niches in those markets. This emphasis stems from a belief that exporting is a major source of growth in revenue and profitability. Thus: H2b: A higher level of export activities is positively associated with company financial performance.

### 3.3 Financial Structure and Performance

Traditionally, financial structure is an important dimension of corporate strategy. Its importance stems from the fact that the ability of a firm to acquire financial resources plays a crucial role in determining its success in the marketplace. Two variables, in particular, are emphasized in this study as indicators of corporate success in developing appropriate financial strategies: leverage position and credit efficiency.

#### 3.3.1 Leverage

This variable refers to the portion of a firm's capital secured through long-term debts; it is operationalized as the debt-to-equity ratio. Several studies have reported a negative association between debt leverage and firm profitability. Higher corporate debt loads tend to depress profits because they increase the burden of servicing the debt. In addition, financial risk increases as this ratio rises because of the increased cost of servicing debt. Moreover, it has been compellingly argued that increased leverage frequently reduces risk-taking by the firm's senior executives. This line of reasoning suggests that benefits from leverage (access to financial resources from external sources) may be far lower than the risks associated with it (conservatism and slowness in corporate activities) which, ultimately, leads to lower profits. Therefore, H3a: Increased leverage is negatively associated with corporate financial performance.

#### 3.3.2 Credit Activities

This variable refers to the ability of a firm to collect its accounts receivables efficiently. Failure to manage credit activities dilutes a firm's financial resources and reduces its cash position. The ability of a firm to collect its accounts is usually measured by the average period it takes the company to accomplish this task. The shorter the period, the more efficient the firm and the higher its performance. Efficient management of credit activities reduces reliance on leverage for financing corporate activities. This helps to counteract the negative side effects of

high leverage, discussed above. Thus: H3b: Efficiency of credit is associated positively with corporate financial performance.

### 3.4 Operations Activities

The value of manufacturing is becoming increasingly recognized as a competitive tool in global markets. Simply stated, manufacturing can make or break an organization. If well managed, manufacturing can be a potent source of competitive advantage and superior corporate performance. A comprehensive review of the literature on operations strategy suggests that three variables are particularly crucial: capital intensity, inventory efficiency, and employee efficiency.

#### 3.4.1 Capital Intensity

As a component of corporate strategy, this variable represents a firm's long-term commitment to building its technological base and upgrading its productive capacity. Capital intensity is defined as total corporate assets divided by sales. Such investments lead to improved production processes that reduce cost or eliminate waste, thus enhancing company performance.

Capital intensity has been the subject of much research in industrial economics and international business. Interest in this variable stems from the recognition of possible substitution of labor and capital in manufacturing. Typically, the question centers on the optimal combination of these two variables (labor and capital), with other factors of production, that lead to an optimal cost structure.

We expect a positive association between capital expenditure and corporate financial resources. This prediction is based on the assumption that capital expenditure, which may dilute short-term resources, will pay off over time. This positive view of the relationship between capital intensity and corporate performance is supported by several classic empirical studies. Past studies and this discussion suggest the following hypothesis: H4a: Capital intensity is positively associated with corporate financial profitability.

#### 3.4.2 Inventory Efficiency

The literature highlights the importance of effectively managing inventory to reduce waste and ensure sufficient supplies for corporate operations. Efficient inventory control is an integral component of an effective operations strategy. As a result, new approaches ensure efficient inventory management. Just-in-time (JIT) techniques and other methods make it possible to plan logistics prudently to improve corporate performance. The popularity of these and similar innovative techniques attests to a growing appreciation by American, Japanese and Korean companies of the implications of inventory management for their profitability and smooth process of manufacturing. Thus: H4b: Inventory efficiency is positively associated with corporate financial performance.

### 3.4.3 Labor Productivity

It has been suggested that labor productivity, measured as the per capita, value added or sales contribution, provides an important indicator of the success of operations strategy. Labor productivity is a major source of corporate performance; the higher this productivity, the higher the corporate performance. This argument rests on a valid assumption: for productivity improvements to occur, successful systems of managing the manufacturing process should exist. Toward this end, American companies have initiated several efforts to reform their managerial practices with the goal of improving labor productivity, as a means of improving their corporate performance. Thus: H4c: Labor productivity is associated positively with corporate financial performance.

## 4. The Moderating Effect of National Boundaries

The literature suggests that the impact of strategy variables on performance varies from one country to another, and even within the same country at different points in time. Therefore, the preceding hypotheses (H1 through H4) should be viewed as contingent (dependent) on country membership.

There are several reasons for expecting the associations to vary by country. First, as argued earlier, the countries vary in their reliance on diversification, use of leverage, capital structure, extent of their export activities, and investment in marketing efforts (e.g., advertising intensity). These differences are expected reflected in different coefficients between individual components of corporate strategy as "predictors" of company performance. Second, companies in the three countries compete in markets that differ significantly in their structure. Japanese and Korean companies are well protected from any massive foreign entry in many segments of their home manufacturing sectors. Such protection enhances the profitability of these firms. American companies do not necessarily enjoy such protected "home base" advantage. Third, the literature suggests that American companies are managed quite differently from Japanese and Korean companies. While differences in the strategic process among companies in different countries are not the focus of this study, we cannot help but wonder if these differences translate into specific sources of competence across countries. Fourth, as mentioned, there are important differences among firms in the three countries in the levels of labor productivity. These differences can be the source of significant cost and price differences in international markets, thus affecting levels of company performance in the three countries differently. These differences, as well as those suggested above in discussing individual hypotheses (H1 through H4), lead to a final hypothesis. H5: Corporate strategy-financial performance associations will vary from one country to another.

## 5. Method

### 5.1 Samples and Data Collection

The samples used in this study consisted of the leading 150 publicly listed manufacturing corporations from the United States, Japan and Korea. These countries were selected because of the different stages of their economic development and the variations in the structure of their national economies. Another reason for their selection is the wide recognition of the important role of the three countries in world trade.

To ensure as valid comparisons as feasible, firms were matched by their sales volume, measured in US\$ million. They were chosen from among the leading 500 companies in each country. The data covered the four-year period of 1996-1999.

Data for American companies were collected from COMPU-STAT, annual reports and 10-K Reports. For Japanese corporations, data were gathered from annual reports of listed companies by the Japanese Chamber of Commerce. Finally, annual reports of listed companies by the Korean Chamber of Commerce were the primary sources of data for South Korean corporations.

### 5.2 Measures

#### 5.2.1 Financial Performance

Corporate performance is multifaceted and, thus, no single measure can fully capture its domain. In addition, preferences for financial performance criteria may vary from one country to another. For example, some Korean firms have opted to forego making significant profits for years to ensure international expansion and growth. Consequently, to gain accurate results and safeguard against the problems associated with any single performance measure, this study employed three indices of major financial performance measures for the 1996-1999 period: return on sales (ROS), return on investment (ROI), and return on assets (ROA), as follows:

∅ Return on Sales = Operating Profit/Sales

∅ Return on Investment = Operating Profit/Investment

∅ Return on Assets = Operating Profit/Assets

#### 5.2.2 Breadth

This study was concerned with the diversification of organization; i.e., reliance on development and specialization of product. Therefore, diversification was operationalized in terms of product specialization. This measure followed the widely-acknowledged entropy measure which emphasized three key elements of a firm's diversification operations: the number of product segments in which the firm operated; the distribution of the firm's total revenues across the product segments; and the degree of relatedness among the various product segments. Accordingly, diversification was operationalized

Accordingly, diversification was operationalized in terms of the ratio of the sales of the major product to the total sales of the firm, as follows:

Diversification =  $1 - (SP_i/TS_i)$  where:  $SP_i$  is the sales volume of the major product and  $TS_i$  is the total sales of the firm in a given year. While this measure is widely used in the literature, it must be noted that it is difficult to identify Korean and Japanese companies' major product lines because of the business groups that dominate those two countries' economies. To safeguard against this problem, multiple secondary sources were consulted to cross-validate the data.

### 5.2.3 Marketing Activities

Two ratios were constructed, using the formula below.

1. Advertising Intensity = Corporate Advertising Expenditure/Corporate Sales Volume
2. Export Level = Export Volume/Corporate Sales Volume

### 5.2.4 Financial Structure

Leverage and credit efficiency were measured as follows:

1. Leverage = Long-term Debt/Equity
2. Credit = (Account Receivables/Total Sales Volume) X 365

### 5.2.5 Operations Strategy

Three formulae were used to gauge operations strategy, as follows:

1. Capital intensity = Fixed Assets/Total Assets
2. Inventory efficiency = Inventory (book value)/Sales
3. Labor productivity = Corporate Sales Volume/Number of Full-Time Employees

All measures were calculated using the four-year averages. This 4-year average allows us to eliminate extremes in the data and year-to-year variations that might obscure trends. Further, we believe that this time frame is necessary to observe the results of corporate international activities. Shorter time frames do not afford us such an opportunity.

## 6. Analysis and Results

### 6.1 Overview

Data for each country were analyzed separately to avoid problems associated with translating currencies using volatile exchange rates. Separate analyses also controlled for variations in accounting conventions among Japanese, Korean and American companies.

As a first step, Pearson's simple correlations among the independent variable set (i.e., components of corporate strategy) for each country were examined to determine lack of multi-collinearity. In the Japanese sample,

correlations ranged between -.44 to .23. For the Korean sample, correlations ranged between .02 and .37. For the American corporations, intercorrelations ranged between -.01 and .34. These ranges suggested the independence of predictor variables. Further, we tested for multicollinearity using the procedures outlined in Neter et al. (1989). These analyses suggested that multicollinearity was not a serious issue in the current data.

Multiple regression analysis served as the primary technique for testing hypotheses 1 through 4.

To test the study's fifth and final hypothesis, the Chow test was employed to find whether the results of regression analyses (9 runs = 3 regressions X 3 dependent variables each) were statistically different.

### 6.2 Japanese Companies

Table 1 shows that the three regression analyses for the Japanese sample were statistically significant (all at  $p < .05$ ). The explanatory power ( $R^2$ ) of the regression models varied:  $R^2$  was .19 for ROS, .31 for ROA, and .41 for ROI. These results supported the importance of corporate strategy variables as correlates of corporate financial performance.

	Performance Criteria		
	ROS	ROA	ROI
<u>Domain Breadth</u>			
Diversification	-.02	-.11	.04
<u>Marketing Strategy</u>			
Advertising Intensity	.16*	-.12	-.12**
Export Level	-.08	-.03	-.08
<u>Financial Strategy</u>			
Leverage	-.02	-.02	-.06
Credit Policy	.09	-.23**	-.39***
<u>Operational Strategy</u>			
Inventory Efficiency	-.01	-.46***	.68***
Employee Productivity	-.32***	-.06	.07
Capital Intensity	-.09	-.36***	-.16**
Constant	.91	.42	.19
$R^2$	.19	.31	.41
F	4.15***	8.21***	40.51***

\*  $p < .05$   
 \*\*  $p < .01$   
 \*\*\*  $p < .001$

Table 1 also showed that different dimensions of corporate strategy exhibited different associations with financial performance. This supported the literature suggestion to use multiple performance indicators. For instance, Table 1 shows that advertising intensity was related to ROS positively but employee productivity was negatively associated with this measure. Note that inventory efficiency was associated positively with ROA and ROI whereas a high credit policy and capital intensity

were associated with lower ROA and ROI. Finally, advertising intensity was significantly associated with ROI.

### 6.3 Korean Companies

The Korean sample exhibited different patterns of associations between corporate strategy and financial performance criteria from those observed earlier in the Japanese sample, at least in three aspects (see Table 2). First, Korean firms with higher levels of diversification had higher returns compared to other companies selected for this study. The beta value of the diversification ratio had a strong positive association with the three company financial performance measures: ROS, ROA and ROI.

	Performance Criteria		
	ROS	ROA	ROI
<u>Domain Breadth</u>			
Diversification	1.13***	.53***	.99***
<u>Marketing Strategy</u>			
Advertising Intensity	-.66***	-.28**	-.58***
Export Level	-.06	.02	-.02
<u>Financial Strategy</u>			
Leverage	.02	.03	-.10
Credit Policy	.04	-.11	.03
<u>Operational Strategy</u>			
Inventory Efficiency	-.05	.11	-.16
Employee Productivity	.06	-.13	.27
Capital Intensity	.09	.04	.14
Constant	-.01	1.15	.00
R <sup>2</sup>	.69	.14	.47
F	39.72***	3.12**	15.91***

\* p < .05  
\*\* p < .01  
\*\*\* p < .001

Second, the intensity of advertising expenses was negatively related to the three corporate financial performance criteria. In other words, the more money that Korean companies spent on advertising relative to their sales volume, the less return on sales, assets, and investment.

Finally, these dimensions of corporate strategy were fairly powerful in explaining ROS and ROI (R<sup>2</sup> = .69 and .47). ROA was primarily affected by other factors beyond those included in this study since the R<sup>2</sup> is equal to .14. Such low R<sup>2</sup> is quite common in many studies of competitive strategy even when the number of predictor variables is very large. Clearly, corporate strategy is one of many factors that influence financial performance.

### 6.4 US Companies

The three regression models for the American sample were significant (all at p < .05), with R<sup>2</sup> ranging from .21 to .41, as shown in Table 3. These R<sup>2</sup> were smaller than

those observed in the Japanese and Korean samples. The results for the American sample are presented in Table 3. ROS, ROA, and ROI were associated positively with two variables: advertising intensity and inventory efficiency. ROS was also associated positively with credit policy and capital intensity. Clearly, the pattern of relationships in the American sample was different from the preceding results of both the Japanese and Korean corporations.

	Performance Criteria		
	ROS	ROA	ROI
<u>Domain Breadth</u>			
Diversification	.05	.03	-.01
<u>Marketing Strategy</u>			
Advertising Intensity	.16*	.14*	.13*
Export Level	.07	.11	.09
<u>Financial Strategy</u>			
Leverage	-.02	-.12	.05
Credit Policy	.17*	.02	.00
<u>Operational Strategy</u>			
Inventory Efficiency	.37***	.53***	.62***
Employee Productivity	.07	.10	.01
Capital Intensity	.02*	.05	-.00
Constant	-.03	-.01	-2.21
R <sup>2</sup>	.21	.35	.41
F	4.94***	10.05***	12.89***

\* p < .05  
\*\* p < .01  
\*\*\* p < .001

### 6.5 Comparisons of the Results Across Three Nations

This section will compare and contrast the results of the study's first four hypotheses (H1 through H4). Clearly, the results vary from one country to the next, as summarized in Table 4, which presents a comparison of the three samples.

#### 6.5.1 Breadth (H1)

Diversification strategy is not associated with higher corporate performance for Japanese or American companies, but is significant in Korean firms. Therefore, the general hypothesis of the positive relationship between diversification and corporate performance is not fully supported in this study. A possible explanation for the lack of success of the diversification strategy of Japanese and American firms is that the companies in this sample are, for the most part, multinational enterprises - their product lines are broad. This raises the possibility that diversification in these firms might have taken them away from their core businesses. If this situation is true, diversification is tantamount to wasted resources.

Another possible reason for lack of significant association between diversification and company financial performance

formance emerges from the literature: most diversification efforts fail to enhance company performance and productivity. This failure stems from lack of experience by senior managers in new lines of business, lack of synergy between new and existing units, and differences in organizational cultures among new and old units in the portfolio. Finally, there is the possibility that some diversification efforts pay off handsomely but it takes a considerably longer period (than the period examined here) to do.

Table 4  
The relationship between corporate strategy and performance: Regression of three samples

	Performance Criteria *		
	Japan	Korea	US
<u>Domain Breadth</u>			
Diversification	NS	S (+)	NS
<u>Marketing Strategy</u>			
Advertising Intensity	XD	S (+)	S (+)
Export Level	NS	NS	NS
<u>Financial Strategy</u>			
Leverage	NS	NS	NS
Credit Policy	M (-)	NS	M (-)
<u>Operational Strategy</u>			
Inventory Efficiency	M (+)	NS	M (-)
Employee Productivity	L (-)	NS	L (-)
Capital Intensity	M (-)	NS	M (-)

\*For each sample

- S = Consistently significant using the three performance criteria
- M = Significant on two performance criteria
- L = Significant on only one criterion
- XD = Mixed support
- NS = Not significant
- + = Positive relationship
- = Negative relationship

### 6.5.2 Marketing Strategy (H2)

Surprisingly, expansion via exporting does not seem to bring a higher return for firms in the three nations examined here. This may be the result of the similar size of the firms in this study and their international experience. Exporting is the first step in entering the global market. Once they have established their export business, companies tend to take advantage of other international activities such as sourcing, offshore production, and direct investment.

The above explanation gains credence as evidence on the export behavior of American, Japanese and Korean firms is reviewed. It appears that Japanese, Korean and Pacific Rim countries have gained prominence in international trade by encouraging their small companies to be active in exporting. So, the benefits for larger companies may be limited whereas smaller firms gain considerably from international commerce.

In contrast to exporting, increasing advertising expenditure brings different financial results depending on

where the firm is located. For American firms, a higher advertising expenditure relative to sales is associated with better financial performance. On the other hand, if Korean firms spend more on advertising, their payoff is negative. For the Japanese firms, an increase in advertising expenditure brings mixed results, either improving or decreasing corporate financial performance. These results may reflect the level of the stage of economic development. Developed countries tend to spend more on advertising than developing and newly industrialized nations. While developed countries employ advertising to stimulate consumer demand, in other nations - where supplies of consumer goods are limited - advertising is an important selling tool to diversify demand from supply-constrained products to those which are plentiful. This is why an increase in advertising intensity has led to negative financial returns in Korea in the current study. For Japanese firms, the impact of advertising on financial performance is inconclusive, although Japan has reached the developed country status. A possible reason for such a mixed signal is that the Japanese market structure is based on imperfect competition between networks of controlled or closed channels of distribution. Consumers have limited choices of what is available in stores.

### 6.5.3 Financial Strategy (H3)

The results show that financial leverage is not associated with high corporate financial performance. An explanation is that companies (especially in the United States) are sometimes leveraged beyond their optimal level. Therefore, the cost of capital may offset any benefits from their leverage position. Interestingly, the more efficient an American or Japanese firm is in managing the credit it provides, the poorer is its financial performance. An explanation is that the impact of efficiency in managing credit may vary from one line of business to another. This means that the total efficiency index should be "decomposed" to examine the effect of its different components on financial performance. Another, and perhaps, more compelling explanation is that most companies offer credit terms and are generally efficient in managing their accounts receivables; this means that in today's competitive markets the efficient management of credit is required to do business but insufficient on its own merit to improve corporate performance.

### 6.5.4 Operational Strategy (H4)

For Korean firms, none of the measures under the operations strategy correlate significantly with the three financial performance criteria. For Japanese and American firms, the results are different. Inventory efficiency is positively related to the measures of financial performance; employee productivity is negatively associated with the financial performance; and capital intensity is negatively associated with the financial performance. Japanese firms have mastered the craft of operating inventory efficiently while American firms have imitated Japanese practices to increase their competitiveness. The

achievements of firms in these two countries have led to a lower level of inventory in relation to their sales volume. For Korean firms, inventory efficiency has been a less crucial factor to their competitiveness because of their low labor costs, reliance on small enterprise, and their use of many Japanese manufacturing practices.

On the surface, the negative relationship between employee productivity and corporate financial performance for Japanese and American firms is perplexing. Increasing sales per employee does not lead to better financial performance. This result can be explained by using the Leontief paradox. It suggests that developed countries' competitiveness depends on their production using skilled labor which causes exports to have a high labor intensity. Growth opportunities in the global market for firms in developed countries such as Japan and the United States require the use of high-skilled labor. This causes the employee productivity measure (sales volume divided by the number of employees) to be inversely associated with corporate financial performance.

Conversely, firms in newly-industrialized nations like Korea are facing a process of transition to move away from producing less low-tech to more high-tech items. That is probably why the relationship between employee productivity and financial performance is not significant.

One possible reason for a negative relationship between capital intensity and corporate financial performance is that Japanese and American firms rival each other for the position of the global economic leader. Investing in fixed assets to increase future productivity is one way to achieve a leadership status at the expense of short-term financial performance. Therefore, hypotheses H4a-c are partially supported.

#### 6.5.5 Moderating Influence of National Boundaries (H5)

The above discussion of cross-country differences and the statistical results support the fifth hypothesis (H5); the relationship between corporate strategy and financial performance differs in strength and magnitude from one country to another. This was confirmed using the Chow test, where seven of the nine regression runs (3 countries X 3 dependent variables) were statistically significant at  $p < .05$ . This suggested that the regression equations reflected very different situations and exhibited different structures.

The different results for each country suggest that theories of corporate strategic behavior need to be grounded in a thorough understanding of the national economy and culture. That is, universalistic assertions should be replaced with a well-crafted contingency model of organizational strategy. This message is consistent with the thrust of Michael E. Porter's (1990) work, as well as the conclusions reached by Alfred Chandler (1990). Using very different research designs and methods, both Chandler and Porter reach essentially the same conclusion: countries employ very different strategies to establish their lead in particular industries. These strategies build on the unique features of the domestic econ-

omy, national character and resource advantage. This implies that American, Japanese and Korean firms would employ very different strategies in asserting their competitive lead in international markets. Companies in these countries have expanded internationally at very different points in time, taking advantage of the distinct skills and competencies they developed in their home base or acquired through international trade. The point is: a theory of international competitiveness would benefit greatly from reviewing existing evidence and then postulating specific country-by-country hypotheses depending on the nature of the national economy and its stage of evolution.

## 7. Conclusions and Suggestions

This study has examined the relationship between corporate strategy and financial performance in three countries. As we expected, components of corporate strategy are correlated differently with different financial performance criteria within and across the three countries. That is, the relative significance and magnitude of the component of strategy have varied according to the criteria used and the country under consideration. Diversification emerges as the key strategy for Korean corporations in their effort to increase financial performance. For American firms, and to a certain extent Japanese firms, advertising is the major correlate of financial performance.

Future research on the topic would benefit from using different measures of corporate strategy variables. For instance, an alternative or more detailed measure of the diversification, financial, marketing and operations components may yield very different results from those found in this study.

Another useful study would be to look at the complete life-cycle of overseas corporate strategy. Although most of our hypotheses were partially supported by the results, the data provided only a snapshot of the corporate strategies under consideration. Strategy is drawn from a series of decision making. Better parallels can be drawn if comparisons are made at similar points in the corporate histories under examination. It would be unrealistic to expect the companies of different nations to employ the same strategies at the same time. Therefore, longitudinal research designs would allow a thorough evaluation of the effect of corporate strategy on performance.

A third possibility for future studies is to examine the impact of strategy on corporate performance by industry types. Although insignificant in this study, other studies suggest that different industries exhibit distinct characteristics in Korea, Japan, and the United States. These characteristics can explain possible differences in corporate performance.

This study highlights the importance of corporate strategy for understanding financial performance. The nine regression performance equations are statistically significant ( $p < .05$ ). Moreover, the results show that the efficacy of different strategy dimensions varies across countries. While the findings for particular dimensions are not consistent with theory-based predictions, they

only highlight the need for more theory building in this area and for large scale empirical studies to gain a better appreciation of the full ramifications of corporate strategy for company performance. We hope that this paper and its results encourage other researchers to test its findings or provide alternative frameworks that will enrich the field.

## References

- [1] Barney, J. "The resource-based model of the firm: Origins, implications, and prospects," *Journal of Management*, 1991, 17(1), 97-98.
- [2] Chandler, A. *Scale and scope*. Cambridge, MA: Harvard University Press, 1990.
- [3] Chowdhury, A. "M & A mania: Tokyo Raiders turn to new Europe," *Asian Finance*, 1990, 16(5), 18-19.
- [4] De Castro, J.O. & Chrisman, J.J. "Order of market entry, competitive strategy, and financial performance," *Journal of Business Research*, 1995, 33(2), 165-177.
- [5] Dollar, D. & Sokoloff, K. "Patterns of productivity growth in South Korean manufacturing industries, 1963-1979", *Journal of Development Economics*, 1990, 33(2), 309-327.
- [6] Grant, R.M. *Contemporary strategy analysis*. New York, NY: Basil Blackwell, 1991.
- [7] Hax, A.C. & Majluf, N.S. *The strategy concepts & process*. Englewood Cliffs, NJ: Prentice-Hall, 1991.
- [8] Hodock, C.L. "Strategies behind the winners and losers," *Journal of Business Strategy*, 1990, 11(5), 4-7.
- [9] Hoskisson, R.E., Hitt, M. & Hill, C.W. "Managerial risk taking in diversified firms: An evolutionary perspective," *Organizational Science*, 1991, 2(2), 296-315.
- [10] Jain, S.C. *International marketing management*. Boston, MA: PWS-Kent Publishing, 1990.
- [11] Katz, J.P., Zarzeski, M.T., & Hall, H.J. "The impact of strategy, industry, and culture on forecasting the performance of global competitors: A strategic perspective," *Journal of Business Strategies*, 2000, 17(2), 119-143.
- [12] Lee, J. & Blevins, D.E. "Profitability and sales growth in industrialized versus newly industrialized countries," *Management International Review*, 1990, 30(1), 87-100.
- [13] Lehn, K. & Makhija, A.K. "EVA & MVA: As performance measures and signals for strategic change," *Strategy & Leadership*, 1996, 24(3), 34-38.
- [14] Levine, D.I. "Participation, productivity, and the firm's environment," *California Management Review*, 1990, 32(4), 86-100.
- [15] Lieberman, M.B., Lau, L.J. & Williams, M.D. "Firm-level productivity and management influence: A comparison of U.S. and Japanese automobile producers," *Management Science*, 1990, 36(10), 1193-1215.
- [16] McGahan, A. M. "Competition, strategy, and business performance," *California Management Review*, 1999, 41(3), 74-101.
- [17] Miller, R. "Profiting in the Pacific rim," *Target Marketing*, 1990, 13(3), 26-28.
- [18] Mintzberg, H. "The design school: Reconsidering the basic premises of strategic management," *Strategic Management Journal*, 1990, 11, 171-196.
- [19] Oster, S. M. *Modern competitive analysis*. New York, NY: Oxford University Press, 1990.
- [20] Pelham, A.M., "Influence of environment, strategy, and market orientation on performance in small manufacturing firms," *Journal of Business Research*, 1999, 45(1), 33-46.
- [21] Porter, M.E. *The competitive advantage of nations*. New York, NY: Free Press, 1990.
- [22] Remolona, E.M. "Understanding international differences in leverage trends," *Federal Reserve Bank of New York Quarterly Review*, 1990, 15(1), 31-42.
- [23] Schmenner, R.W. & Rho, B.H. "An international comparison of factory productivity," *International Journal of Operations & Production Management*, 1990, 10(4), 16-31.
- [24] Stimpert, J.L. & Duhaime, I.M. "Seeing the big picture: The influence of industry, diversification, and business strategy on performance," *Academy of Management Journal*, 1997, 40(3), 560-583.
- [25] Umezawa, M. "Japan's advertising boom-globalization holds the key to the future," *Tokyo Business Today*, 1990, 58(8), 22-23.
- [26] Zahra, S.A. & Garvis, D.M. "International corporate entrepreneurship and firm performance: The moderating effect of international environmental hostility," *Journal of Business Venturing*, 2000, 15(5/6), 469-492.

# Reconsidering Adoption Behavior: Models Beyond Diffusion

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## Abstract

Classic diffusion theory is effective and useful at describing adoption of technologies or certain behaviors. However, innovation adoption is not the only kind of adoptive behavior. Communication specialists encourage the adoption of brands, fads, political positions and behaviors that may not necessarily be innovative. This paper discusses an alternative model for the adoption called resonance that is less sensitive to past assumptions. Resonance replaces prior models to describe adoption such as diffusion, critical mass and collective action. Resonance proposes two forces at work a motivating force and a receptive mass. The two work together to create the adoption event. The motivating force provokes the event and the receptive mass supplies the energy. The model is applied to a communication systems forum to make it more useful to telecommunication systems.

## 1. Introduction

Classic diffusion theory is effective and useful at describing adoption of technologies. However, innovation adoption is not the only kind of adoptive behavior. Communication specialists encourage the adoption of brands, fads, political positions and behaviors that may not necessarily be innovative. At the same time, the economics of communications has changed dramatically as industries deregulate and converge. Online communication systems continually lower the cost of adoption leading to changes in adoptive behavior not anticipated by current models.

It becomes more difficult to effectively apply traditional diffusion theory as key elements are removed. First, success can be defined as "enough" adoption rather than universal adoption -- even within a group. Second, critical mass of adoption need not occur within a specified time frame. Third, easy and perceptively cheap adoption opportunities lessen the importance of product characteristics.

This paper will reconsider the adoption process within a framework more in tune with current market trends. The goal is not to abandon current adoption studies but rather to enliven them by mixing alternative theoretical foundations. This paper will discuss an alternative model for the adoption that is less sensitive to past assumptions. The goal is to create a model that can be ap-

plied to more behaviors and technologies. Specifically, the model should be useful in information systems.

## 2. Classic Diffusion of Innovations

Diffusion of innovations and its sub-theories, dominate adoption literature for very good reasons. The model achieves an effective parsimony in design. At the same time, diffusion is rich enough in scope to permit multiple testing areas. The long tradition of research in this area makes diffusion one of the most thoroughly applied models in existence today.

Rogers [13] proposed a "diffusion of innovation" model most effectively with his seminal book *Diffusion of Innovations*, first published in 1962. The emphasis of diffusion was to describe the process by which innovations are adopted by a population. Key concepts, most often studied by others, include (a) attributes of the innovation, (b) adopter classes/ innovation life cycle, and (c) the innovation-decision process.

Attributes of the innovation include relative advantage, compatibility, complexity, trialability, and observability [15, p. 210-234]. Successful manipulation of these attributes should result in a greater chance of innovation success. For example, America Online offers 700 hours of its service free to enhance trialability. These attributes are useful for predicting which innovation or marketing plan would be most successful.

The innovation would go through an adoption life cycle complete with heterogeneous groups adopting at different times in the life cycle. The stages include innovator, early adopter (sometimes called early adapter), early majority, late majority and laggard [15, p. 247-251]. Most of the study in this area concentrates on the first two or three stages. The farther along an innovation is in the diffusion life cycle, the more likely it will succeed. This life cycle process tends to take on a normative, pro-innovation stance. For example, the first to adopt are innovators and the last are laggards. Later theorists developed the description of the innovator/early adopter process to enhance the model (see Critical mass section below).

Finally, a too often overlooked area of diffusion studies considers the diffusion process of individual decision makers. The individual might go through five stages in the process including (a) knowledge, (b) persuasion, (c) decision, (d) implementation and (e) confirmation [15, p. 163-195]. At each stage, an effective researcher or

marketer could find the factors to increase the likelihood of innovation adoption. Through these stages, Rogers effectively describes the opportunity for adopter class interaction. However, the model concentrates on information seeking behavior or opinion leadership.

### 2.1. Critical Mass

Markus [6] modified the traditional diffusion curve to allow for the possibility that non-adopters could affect adopters. Under this model, current adopters will not continue to use an innovation if others do not also adopt. After a finite period of time, if the medium is not adopted by a certain percentage of the community then current users will revert to another technology.

Critical mass is not a single theory so much as a general concept upon which theoretical models have been built. In many cases, it fails to rise to the "theory" level and is really simply an analogy. The original analogy refers to the term's proper use in physics -- the minimum amount of a nuclear fuel necessary for an explosive chain reaction. In practical use, "critical mass" can be defined as the minimum amount of some resource (people, money, etc.) needed before another condition or product explodes into existence. For example, Hiltz [4] suggested that there was a critical mass of participants needed for the success of a computer discussion forum. The physics analogy also acknowledges the idea that the mass is unstable and in a constant state of decay. If the minimum mass is not collected in time, that which has been collected is lost.

Critical mass enhanced diffusion by allowing for some critical changes. It allowed for reciprocal interdependence of heterogeneous adopter classes. It also left open the possibility of an adopter replacing one innovation (or service) for another. While these options were not excluded from diffusion, they were not as formalized. While adopter classes are theorized heterogeneous, most research focused on differences rather than interaction. At the same time, most work involved adopter classes interacting with society rather than with each other.

### 3. Collective Action

While diffusion studies dominated mass communications and business research, a second line of adoption studies developed in sociology and political science. Collective action research concentrated on the motivations of the individuals. While there is significant overlap, collective action took a relatively microeconomic perspective compared to diffusion.

The watershed book for collective action was Olsen's *The Logic of Collective Action* [12]. It considered what motivates an individual to participate in a group effort. Collective action involves situations where a group of previously unorganized individuals must work together to achieve some mutually desirable goal. One popular example is where a group of residents must work together to prevent the closing of a nearby school [8]. Another classic study was on the development of riots. Granovetter [3] attempts to predict the development of riots as a collective action. While riots may seem removed from

information systems, the same forces are at work. Collective action studies assume that:

- 1 Participation requires cost or risk.
- 2 Non-participation will not require cost.
- 3 A common good may be produced without participation.

In collective action individuals must choose to invest in a common good. If successful, everyone will benefit from his or her effort. If not successful, only those that invested effort will lose. Essentially, collective action theorists look at situations where individuals must invest in an activity where they may never benefit. In addition, others that do not participate may benefit from the action. Non-participants who enjoy the common good are called "free riders" on the collective action.

For example, suppose a local radio disk jockey has been offending the community. A growing group may wish to get rid of him but how do they start? The effort will be time consuming and require a risk to one's personal reputation. It is also possible that the situation could resolve itself if left alone. A local minister is particularly interested and decides to lead the fight. Others choose to adopt the cause as well when their personal interest level is met. If the effort is successful, all interested will enjoy the departure of the disk jockey. If it is unsuccessful, those that participated will have wasted their time and damaged their reputation.

Collective action theorists assume that potential groups are made up of people that have different levels of the desire to participate [7] [9] and who elect to participate either through rational decisions [6] [11] or based on learned behavior [6]. Decisions to participate are based on a combination of perceived cost, anticipated value and personal interest [9]. Most collective actions are caused by action that originates with one person or a few people who plan a campaign and purposely draw others into it [10]. Participants become a part of an interest group desire a collective action, [7]. A collective campaign includes the activities oriented toward that goal while social movements are actions by people who can and do change their responses over time.

What is interesting about a collective action is how fragile or powerful it can be. Collective action describes events that can quite literally change the direction of a society. At the same time, the collective action can fail for the want of a single person. Since inclination to participate is dependant (in part) on a likelihood of success, Dick [2] observed that the lack of a single individual may doom a small collective action. The collective action could also be self-limiting. Oliver [11] effectively described a scenario where potential participants realize that they will not make a significant contribution to a collective action. As such, their motivation to contribute would decline.

Collective action studies do not consider alternatives to the CA. While opportunity costs are considered a part of the costs of a CA, these costs are simply considered the cost of doing "something else." Surely there is no discussion of joining riot A or riot B. Therefore; attributes of the adopted behavior are not well developed.

#### 4. Linking it Together

What are the common elements between the two foundations?

Heterogeneous participation: Both foundations allow for heterogeneous levels of participation. In diffusion, adopter classes are described as distinct subgroups of the larger population -- complete with demographic and psychographic differences. Collective action theorists go further to postulate an individualize "inclination to participate." Some even use a formula to describe a rather mechanical decision making process based on an individual's perception of the potential adoption [9].

Adoption at a cost: Whether it is personal embarrassment or financial loss, both traditions recognize perceived costs as an inhibiting factor for adoption. For example, the main difference between innovators and early adopters in diffusion is the willingness to risk adopting an unsuccessful innovation. Collective action assumes people assess cost, benefits, and likelihood of success before adopting the group behavior.

Critical Mass: Critical mass is a term that comes most from diffusion literature. However, both traditions assume there is a threshold. In diffusion, that threshold happens to be societal. In collective action, each person has a threshold. Once a personal threshold is met, the individual adopts the behavior.

Levels of interaction: Diffusion allows for the possibility of information seeking behavior. This implies that an opinion leader could have a direct influence on the adoption decision of a later participant. Collective action tends to suggest a more passive level of interaction. In effect, the individual will look at other individuals who may or may not be participating in the collective action to see if their personal threshold has been met. This does not imply direct interaction but, at least, an awareness of others.

Time line: A required time line is implicit in collective action. There is, after all, a fine line between a riot and one rebel with a brick. If the brick is thrown and others join in, the rebel becomes a leader. If others do not join, the rebel is arrested. Still, establishing a time line is not center of collective action research. Diffusion has a rather strict timeline. Critical mass theorists formalize the deadline. Establishing the time line is explicitly researched.

Free rider: The free rider comes from collective action models. The free rider is the person that can enjoy the collective good without participating in the production. Diffusion researchers tend to believe that the free rider can be excluded from the innovation. Still, diffusion researchers' normative approach to adopter classes suggests resentment toward the laggard.

Many of these elements still hold true in practical applications. Despite earlier criticisms, these elements are all useful and should be retained in a new model. A single model that can unify all the above elements should be even more powerful.

#### 5. Resonance

The goal of this study is to suggest a new framework for analysis. This new framework should take the best from diffusion, critical mass and collective action research.

Goals for the new model include:

- 1 A more flexible timeline.
- 2 A greater sensitivity to the interaction between adopters.
- 3 An ability to consider smaller scale adoptions.

Since two of the previous models used an analogy to a process borrowed from the hard sciences, this model will as well. A more apt analogy for collective action is that of resonance. Academic American Encyclopedia Letcher [5] describes resonance as:

... the large absorption of energy and the resultant large amplitude of motion that occurs when a vibrating system is driven by an external force at its natural frequency of vibration.

Resonance is a generalized concept used in many fields of study, including physics, electronics, quantum mechanics and chemistry. While individual readers may understand the term from the point of view of one discipline or another, for parsimony, it must be discussed in more generalized terms. In general terms, resonance is used to describe many systems that are dependent on waves of energy in a moving system.

The principles of resonance are at work when a person pushes a child in a swing; the greatest effect will be achieved for the least effort if the force is applied at the natural frequency of the swing and in phase with the motion. Two opposing forces - inertia and restoring force determine the resonance frequency. Inertia causes objects in motion to want to continue to be in motion. Restoring force causes the object to want to return to its resting state. Using a swing as an example, input energy drives the swing beyond its resting state. Inertia would cause the swing to continue away from its original position if it were not for the restoring force (i.e., gravity and a good sturdy rope). When the restoring force overcomes inertia, the swing moves back to its resting position but is carried by inertia beyond. In this way, the input energy activates a chain of forces - each reacting to one another. At resonance frequency, input energy only needs to overcome the mechanical friction of the system. Below resonance frequency, input energy must overcome mechanical friction and the restoring force. Above resonance frequency, input energy must overcome mechanical friction and inertia.

In another example, resonance can be used to describe the relative ability of a musical instrument to produce sound. The instrument is a vibrating system and any such system would have at least one resonance frequency. Energy is applied to the instrument through air movement or vibrating strings. When energy is applied at the proper frequency and time (in phase with the output), the greatest output is produced for the expended effort. At resonance, output power reaches a peak for a consistent effort.

At resonance there should be qualitative changes as well as a quantitative. In a musical instrument, resonance

produces overtones as harmonic frequencies are excited. The entire tonal output becomes more complex and thereby changing the quality of that output. In a practical application, the successful adoption activity may seem to lose focus in resonance as used start to adapt the behavior.

## 6. The Resonance Model

The resonance model assumes that any successful adoption is comprised of two groups. First, a motivating force of people interested enough to lead. Second, a receptive mass that is ready to adopt something – not necessarily this adoption. If the motivating force successfully excites the receptive mass to action, the adoption activity is successful. The keys are the availability of receptive mass and the ability of the motivators to excite the mass.

The relationship between these two groups is more interactive than the normal opinion leader/follower relationship. The resonance model assumes an interaction between current and future adopters. The strength of the model should lie in the ability accommodate adoption. The interaction between adopters and non-adopters can accommodate adoption in two ways. First, on the individual level, those encouraging the innovative behavior must push adoption when the non-adopters are ready. There is an implicit assumption of a social negotiation that would demand adaptation. For example, the American cable channel MTV works very hard to be source of new fads. Still, it does not declare something cool and leave it at that. MTV's research department finds trends with an innate appeal to its demographic group [15]

Second, an interrelationship between past and future successes (or failures) suggests a continuous trial and error process. When Dick [2] studied online forum activity as a collective action, he found that almost all discussion areas had little to no activity. In this study, fifty-six percent of the discussion groups accounted for all of the activity. However, Further, Dick's results indicate a dramatic slope in the distribution where most of the real activity was concentrated in very few areas. If this pattern exists in general adoption behavior, most adoption research concentrates only on relatively rare instances where innovations approach success. For every innovation that gets studied, one thousand may have already been discarded. Adoption occurs by survival of the fittest. We can see this kind of adoption today in the various short messaging/instant messaging services -- each one upgrading to optimum quality. The goal should be to expect adaptation as a normal part of adoption.

### 6.1. Resonance and New Media

A key to the success of a new telecommunication service is a valid estimate of the potential market. Too often, universal adoption is the assumed standard for success [1]. There are good reasons. After all, a communication system cannot be effective unless there is someone with whom to communicate. The natural logic would be that a system is most efficient when everyone is using it. However, the pace of change is such that we cannot depend on universal adoption before obsolescence. Rather

than striving for 100 percent market penetration, new communication systems should change their definition for success to be more realistic. There are several communications activities where even large-scale adoption is undesirable. The tattooed, body-pierced teenager might be horrified to find her parents joining in. In the same way, a citizen band channel is useless if everyone is using it.

Online discussion groups, or forums, provide the framework for our remaining discussion of adoption behavior. These discussion areas are popular on many services, and are seen as an important method for system owners to communicate with their audiences. At the same time, the forum requires the same forces of any adoption behavior. The forum requires shared adoption. There is uncertainty that adoption will yield benefits while it wastes time. As such, they are a reasonable starting point.

Online forums may be studied for a critical mass where the forum fluctuates around a specific level of traffic. A forum provides represents both a communication medium and a collection of individuals that must make a joint investment for a common good. The forum participant must adopt more than just the medium. They must also invest in a project that is only successful if others act in a similar way through replying to the messages. Collective action theory has been extensively developed but has suffered in field trials due to the inability to accurately record the collective action. Since forums records and archives from creation to degeneration, forums offer the researcher more choices in field trials of adoption behavior. What this means to the forum is: Forum leaders (motivating force) drive a previously non-involved group of individuals (receptive mass). The group produces its maximum output at or near a certain frequency.

If the driving force is removed or reduced, the group as a whole can lose its natural frequency and thereby the positive effects of resonance. The quality of the conversation is dependent on the frequency of the conversation (activity level).

Even though a simultaneous force is necessary, this force can be achieved, lost, re-achieved and even become too powerful. Forum leaders are in the position of tuning that force to the proper frequency.

Although the resonance model is used to replace critical mass, it augments the base established in collective action research. The model can be used to better describe the collective action process by dividing it into stages. Individual participation decisions still drive the growth of the collective action. Heterogeneity of participants is emphasized by the categorization of participants into separate classes.

### 6.2. Developing Adoption

In a study of forum activity [2], two critical break points were described. First, critical mass was described as the point at which there was a dramatic increase in the amount of activity. Second, critical saturation was used to describe the point at which activity was so heavy that there was a dramatic decrease in activity. Resonance can be defined as the period of time between these two criti-

cal break points. In the resonance model, these two points become two parts of a single condition. Critical mass becomes the lowest possible frequency of resonance. Critical saturation then becomes the point where the frequency of activity becomes detrimental to future activity going beyond resonance. While some simultaneous force is necessary, this force is not as dependent on a time period from an artificial starting point - such as the building of the swing. Resonance can be achieved as soon as the forces are marshaled. From this point on, the terms "critical mass" and "critical saturation" will not be used. The forum is either in a state of resonance or not.

#### 6.2.1. The Motivating Force

Forum leaders become the motivating force, though not the only force in creating the successful adoption. Not only do they define the forum's environment, they supply the initial energy that activates the mass of potential participants (receptive mass). In this way they give the forum its direction and the mass of participants supplies a reactive energy that gives the forum its real activity. One of these two groups is not enough. The forum leaders reacting without the aid of the mass is similar to the musician attempting to perform without an instrument. The reverse might naturally be true except that leaders might naturally emerge from the mass and become the needed motivating force.

For a forum to become active, it is necessary to have a group of willing participants. Sheer quantity of participants is necessary but not sufficient to start the active forum. Assuming that there is a normal distribution of inclination to participate, the true success relies on the presence of those individuals with an unusually high inclination. A successful forum requires not just a number of people but the actual people willing to participate first. If even one of these people is missing, an otherwise active forum may languish. The group may be willing to participate, if only someone else would start. The leaders provide that initial energy necessary to activate the resulting mass. In this way, the actions of others are, to a great extent, dependent on them.

#### 6.2.2. The Resonance Curve

In the resonance model, qualitative changes and quantitative changes happen together. The result is more of a life cycle model and can be broken up into several stages. Each stage will have its own unique characteristics and will be discussed below.

It should be noted however, that the model represent possible stages of the forum's life cycle not necessary stages. A forum may never leave the "quiet stage." The forum, in this model, must pass from quiet, to definition, to resonance but it may never achieve super-resonance. It is also possible that after recession, it can return to resonance. To emphasize the optional nature of these stages, super-resonance will be discussed after recession.

#### 6.2.3. Quiet

The quiet stage of the life cycle can be viewed in one of two ways. First, it could be at a time in the forum

before the driving force is applied. Second, quiet areas could simply uninteresting topics. Forum leaders do not often know what topics will be of interest to participants. Since resonance requires both leaders and a mass of participants, leaders do not wish to cut off an area that could be potentially active. These areas are trials that have not yet succeeded.

#### 6.2.4. Definition

At some point prior to resonance, the forum should define itself and its market. Like the swing that is trying to overcome the restoring force, the forum is trying to become something other than inactive. To accomplish this, the forum must establish a direction. The definition stage is one where activity and interest level interact. The forum cannot be all things to all people any more than the swing can move in all directions at the same time. The forum will become more interesting to some and less interesting to others. The activity level of past participant affects the qualitative interest level of the forum.

If you assume incoming messages are valuable, then a mass of messages should increase everyone's inclination to participate. But that assumption does not consider a basic premise of resonance -- heterogeneity among participants. If users are truly different, then the values of certain messages are equally different. Messages should cause an increase in the inclination to participate for some users while a decrease for others. As messages increase, a conversation becomes more specific in both topic and level (intellectual, maturity, etc.). The activity will cause the forum to be more interesting but to a smaller group of potential participants. In effect, the collective action is defining its market. This market definition is similar to an instrument being tuned to produce the strongest output (harmonic frequencies).

This portion of the life cycle is probably most similar the original critical mass model. Each system user is making individual participation decisions based on what they believe to be the potential rewards. Loyalty to the group has not yet been established so the restoring force continues to have its greatest effect.

#### 6.2.5. Resonance

During the time of resonance, forum managers have successfully excited the group into action. The leaders' participation should become more enjoyable. The leaders may actually increase their activity (in relation to the rest of the group) at this point simply because it takes less effort and because their experience with the forum lets them know "where the action is." The friendship of the mass of participants should increase as well because information is being exchanged freely and the participants are benefiting from the public good that has been created. At this point, loyalty should develop among participants. This loyalty allows the forum to continue even if there is a momentarily lose of resonance.

#### 6.2.6. Recession

Oberschall [9] suggested that the successful collective action could be reversed by the loss of a minor percent-

age of the group. This idea can be included in this resonance model. For example, assume that summer starts and a forum leader leaves for other activities. Even if most participants are not affected by the change in season, all participants receive less interaction and the value of the forum drops. Since everyone's inclination to participate is equally reduced, other current users withhold participation and the probability of reward diminishes further. An active forum dies due to the introduction of a variable that may not even be important to even a majority of the participants.

Recession is the point when the forum loses its resonance frequency and drops to a level of relative inactivity. Since forum leaders are the driving force, they should be the first to leave at times of recession. Recession may, in fact be caused by their driving force running out of energy. This may be due to a loss of interest in the current topic and a desire to move on to other areas. Using the swing analogy again, recession would occur when the child grows tired or bored and moves on to other toys.

The mass of participants may experience an entirely different effect at the time of recession. Loyalty has been created in the group. Also, since leaders are most likely to be the first to send messages, the mass of participants is more likely to try to continue the topic (not yet bored). The energy originally invested by the leaders will remain for some time after resonance. Inertial energy provided by the receptive mass may push the forum back into resonance.

#### 6.2.7. Super-resonance

Super-resonance occurs when activity exceeds resonance. At this point, management of the interaction should become more difficult because there is much more activity. Conversations should lose their focus and multiple topics should be present. Like the swing that wants to fly off away from the tree, the forum flies away from its center of interest.

Super-resonance may not be enough to kill forum activity but it may motivate participants to limit their contributions. Two separate effects may cause super-resonance. First, participants may simply be unwilling or unable to process too many messages at one time. Participants may find ways to limit their commitment to the group (e.g., put off responding for another time). Second, as Oliver [11] suggested, the forum may reach a point where participants feel they have little to add. In either case, forum activity should not be expected to exceed some maximum level - at least not for long.

## 7. Conclusion

We have already seen communication systems (e.g., citizen band radio, audio cassettes, and microfilm) that are successful on their own terms but will never be universally adopted. It is time to consider these scenarios as we consider adoption.

New opportunities to look at adoptive behavior are available today. This study presents the first attempt to develop this new model for adoptive behavior. The author believes it is time to start the discussion in a fresh

direction. The first step is to lay a theoretical foundation rich enough for further study. The next step is to test past assumptions and those included in this model in light of the demands of current technology.

The model outlined above provides a rich basis for innovative study. First, adoption research needs to look at a greater variety of adoption behaviors. Second, researchers need to look the entire adoption lifecycle including the relationship between one adoption event and the next. Finally, greater attention needs to be paid to the dynamics of the adoption decision.

## Reference

- [1] Allen, D. (1988) New telecommunications services: network externalities and critical mass. *Telecommunications Policy*, 15, 257-271.
- [2] Dick, S.J. (1993). Forum talk: an analysis of interaction in telecomputing systems. Unpublished doctoral dissertation, Michigan State University.
- [3] Granovetter, M.S. (1978). Threshold models of collective behavior. *American Journal of Sociology*, 83(6), 1420-1443.
- [4] Hiltz, S.R. (1988). Productivity enhancement from computer-mediated communication: *Communications of the ACM*, 1438-1454.
- [5] Letcjer, S. V. (1992). Resonance. In *academic American Encyclopedia via CompuServe*, reference section.
- [6] Markus, M.L. (1990). Toward a "critical mass" theory of interactive media. In J. Fulk & C. Steinfield (Eds.), *Organizations and Communication Technology* (pp. 194-218). Newbury Park, CA: Sage Publications.
- [7] Marwell, G., & Oliver, P. (1984) Collective action theory and social movements research. *Social Movements, Conflict and Change* 7, 1-27.
- [8] Marwell, G., Oliver, & P., Prahl, R. (1988) Social networks and collective action: A theory of critical mass. *American Journal of Sociology*, 94, (3) 502-534.
- [9] Oberschall, A. (1980). Loosely structured collective conflict: A theory and an application. *Research in Social Movements, Conflicts and Change*, 3, 45-68.
- [10] Oliver, P.E., Marwell, G. (1988). The paradox of group size in collective action: A theory of the critical mass. II. *American Sociological Review*, 53, (1), 1-8.
- [11] Oliver, P., Marwell, G., Teixeira, R. (1985) A theory of the critical mass. I. Interdependence, group heterogeneity, and production of collective action. *American Journal of Sociology*, 91, (3), 522-556.
- [12] Olsen, (1965). *The logic of collective action: Public goods and the theory of groups*. Cambridge, MA: Harvard University Press.
- [13] Rogers, E.M. (1962). *Diffusion of Innovations*. New York: Free Press.
- [14] Rogers, E.M. (1986). *Communications Technology: The New Media in Society*. New York: Free Press.
- [15] Rosen, (2002). *Publishers Weekly* July 22. 84-86

# Taiwan Internet Diffusion: An Empirical Study of Internet Interactive Effects

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## Abstract

The primary objects of this research were applying the innovation diffusion model to internet hosts and internet subscribers. The results of this study may be a useful reference to the further concept building of the relationship of innovative and adopters.

## 1. Introduction

During the last decade, there has been a lot of optimism regarding Internet Development. Reports and news showed that Internet growing at an exponential pace with no predictable upper bound or saturation limit. However, in March 2000, with NASDAQ Internet stocks falling, no one thought about it but rather than returned to the reality. [4][6]

Internet hosts' and Internet subscribers' growth at an exponential pace happened in early stage of Internet development. Common customer frustrations are concluded because of slow response time, inaccessible online service...etc. These problems can follow inadequate capacity planning caused by ignorance of the Internet growth pattern. [2]

After a six-year growth boom, Internet growth rate slow down. Analysts are claiming that Internet adoption by consumers has essentially saturated. Since Internet stock fell, stockholders are eager to see the real profit than gold in the heaven.

Thus for Internet companies accessing Internet subscribers and hosts accurately is a daunting but increasing important task. The purpose of this study is to understand Taiwan internet diffusion models of internet subscribers and internet hosts and the relation between internet subscribers and internet hosts.

## 2. Internet Diffusion

### 2.1. Internet Diffusion Model

The diffusion model is one classical model used to study the impact of a specific technology. The model is informed by the diffusion of innovation and various

economics theories and assumes that non-adopters of an innovation are increasingly likely to imitate adopters.

In other words, one person adopted because he or she observes the success of another person who has already adopted.

However, the number of adopters in a social system has its upper limit. Thus growth rates increases first and then decreases over time to achieve a finite saturation level. We call the point at the maximum growth rate of the growth models "the inflection point". Some growth curves are called "S-Curve" because of its shape.

Empirical studies shows the model have been used in many disparate fields such as social study ,public health ,management, sociology, marketing, communication networks to model diffusion through a population of adopters or subscribers.[7]

### 2.2. Mathematics form of growth model

There are three common growth models –the exponential model, the logistic model and the Gompertz model. [3]

#### 2.2.1. The exponential model

The exponential model assumes a constant rate of growth and thus does not involve either an inflection point in the growth rate or a definite saturation limit. Some studies shows in the early stages of its diffusion, the exponential model is suitable for understanding the growth. And the form of the exponential model

$$Y=A*\exp( B*T) \quad (1)$$

In equation (1), Y is the cumulative number of existing adopters. A、 B are constants. T is the period.

#### 2.2.2. The Logistic model

Unlike the exponential model, the logistic model assume variable growth rate whereby the growth rate first increase and then decrease over time. The form of the Logistic model (also known as Pearl model)

$$Y=A/(1+B*\exp(-C*T)) \quad (2)$$

In equation (2) , Y is the cumulative number of existing adopters. B、 C are constants. T is the period. A is the upper limit of Y.

### 2.2.3. The Gompertz model

In this model, the rate of diffusion is a function of existing adopters and the difference between the logarithms of the number of adopters at the saturation level and the existing number of adopters. The form of the Gompertz model

$$Y=A*\exp(B*\exp(C*T)) \quad (3)$$

In equation (3),Y is the cumulative number of existing adopters. B、 C are constants. T is the period. A is the upper limit of Y.

### 2.3. Interactive Process of innovations and adopters

The Internet is a communication mesh of networked computers with their associated resources, including but not limited to email, ftp, gopher and the web. Organizations and individuals may adopt and use varying subsets of the Internet. [5]

In other words, Internet users could communicate with each other through “Internet” such as email, news groups...etc and interact with internet resources (webs, mail servers, ftp servers).

This interactive process first studied in the 1980s by diffusion researchers. Researchers found that interactive innovations (telephone, fax, email) possess different characteristics from innovations spread in the normal diffusion networks (mass media, interpersonal networks).

The main feature of the interactive process of innovations and adopters is its two-way communication process. In the case of non-interactive innovations, the earlier adopters have a sequential interdependence effect on later adopters. But in the case of interactive innovations, not only earlier adopters influence later adopters but later adopters also influence earlier adopters.[9]

Based on interactive innovations, one researcher showed internet client-server architecture may cause a new many-to-many communication model. .

In dual acceptance theory, diffusion of internet adopters depends upon internet servers whereas the diffusion of the web server depends upon internet users.

Chen’s study indicated that if there are only a few web servers, using the web is of little value to users. Similarly, if there are only a few web users on the internet,

creating a web server is of little value to organizations or business. That is the rate of adoption of web servers depends upon the number of users, not the number of web servers.[1]

## 3. Research Method

This study attempts to use diffusion model to access diffusion models of Taiwan internet users and internet hosts ,but also to fit the dual acceptance model.

The data of Taiwan internet hosts comes from Internet Software Consortium. The number of Taiwan Internet hosts equals to the sum of the number of .tw domain name and the number of hinet.net domain name. Hinet is the largest ISP in Taiwan and other ISP domain name is including in .tw domain name. The data of Taiwan internet users comes from Taiwan Directorate of Telecommunications.[8]

At the beginning this study, we use the data of internet users and hosts in Taiwan to fit the diffusion model . Secondly, we apply Taiwan Internet diffusion model for dual acceptance model.

Table 1 Taiwan Internet hosts

Time	Taiwan Internet Hosts
Jan-95	14618
Jul-95	16166
Jan-96	25273
Jul-96	30645
Jan-97	34650
Jul-97	40533
Jan-98	176836
Jul-98	353523
Jan-99	519597
Jul-99	676623
Jan-00	849652
Jul-00	1156573
Jan-01	1349261
Jul-01	2293024
Jan-02	3433129
Jul-02	3544102

Source: Internet Software Consortium

Table 2 Taiwan Internet Users

Time	Taiwan Internet Users (thousands)
Jul-96	440
Jan-97	600
Jul-97	1260
Jan-98	1660
Jul-98	2170
Jan-99	3010
Jul-99	4020
Jan-00	4800

Jul-00	5600
Jan-01	6273
Jul-01	7214
Jan-02	7824
Jul-02	8080

Source : Taiwan Directorate of Telecommunications

#### 4. Analysis and Discussions

##### 4.1. Analysis of Taiwan Internet Hosts

We use the data regarding the number of Taiwan Internet hosts from Jan-95-Jul-00 at half-year intervals, based on reports publish by Internet Software Consortium to fit three growth models. Which model is the best? For  $R^2$ , these three growth models are acceptable. (Table3)

Table.3 Regression Models of Taiwan Internet hosts

Model	$R^2$	Model
Logistic	0.981 3	$Y=6794521/(1+844.38*\exp(-0.4339*t))$
Gompertz	0.976 0	$Y=65693134*\exp(-10.70*\exp(-0.0826*t))$
Exponentia	0.973 1	$Y=33328*\exp(0.2976*t)$

##### 4.2. Analysis of Taiwan Internet Users

We use the data regarding the number of Taiwan Internet hosts from Jan-95-Jul-00 at half-year intervals, based on reports publish by Internet Software Consortium to fit three growth models. Which model is the best?

For  $R^2$ , these three growth models are acceptable. (Table 4) But if we look at the trend of the three model, the exponential model seems not unacceptable.

Table.4 Regression Models of Taiwan Internet Users

Model	$R^2$	Model
Logistic	0.998 2	$Y=9044.2858/(1+80.38*\exp(-0.4089*t))$
Gompertz	0.998 2	$Y=11366.30*\exp(-7.7977*\exp(-0.1997*t))$
Exponentia	0.937 1	$Y=701.3346*\exp(0.1607*t)$

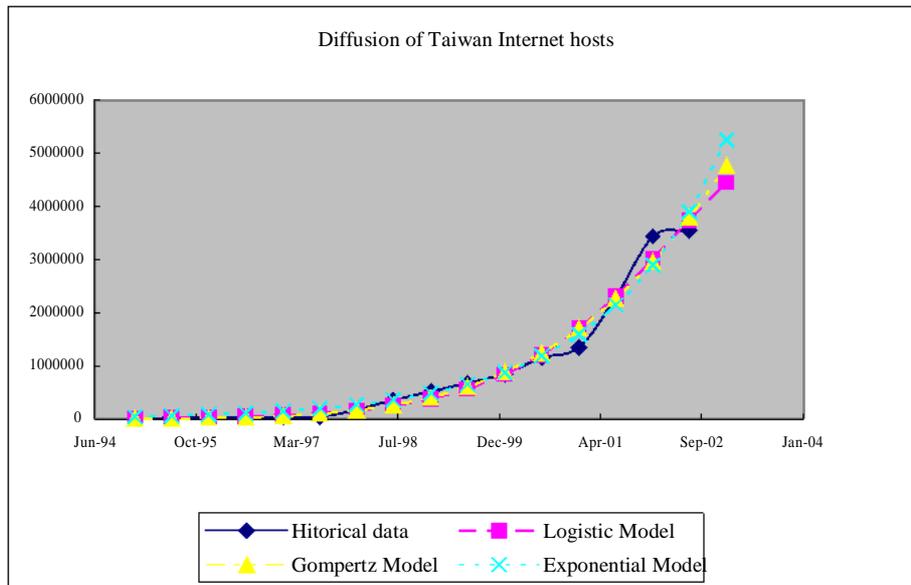


Figure 1 .Diffusion of Taiwan Internet hosts

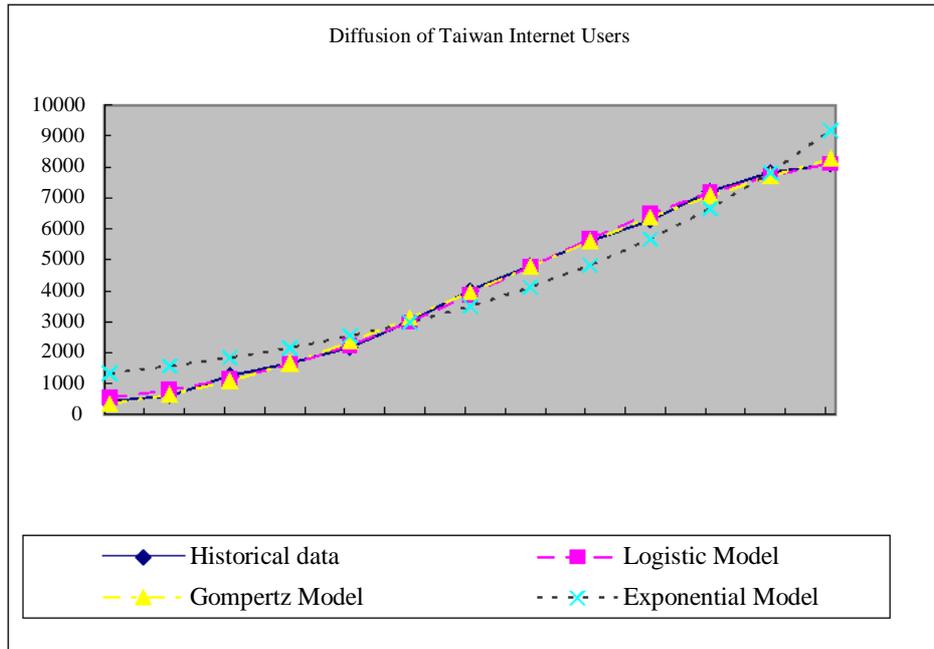


Figure 2 .Diffusion of Taiwan Internet Users

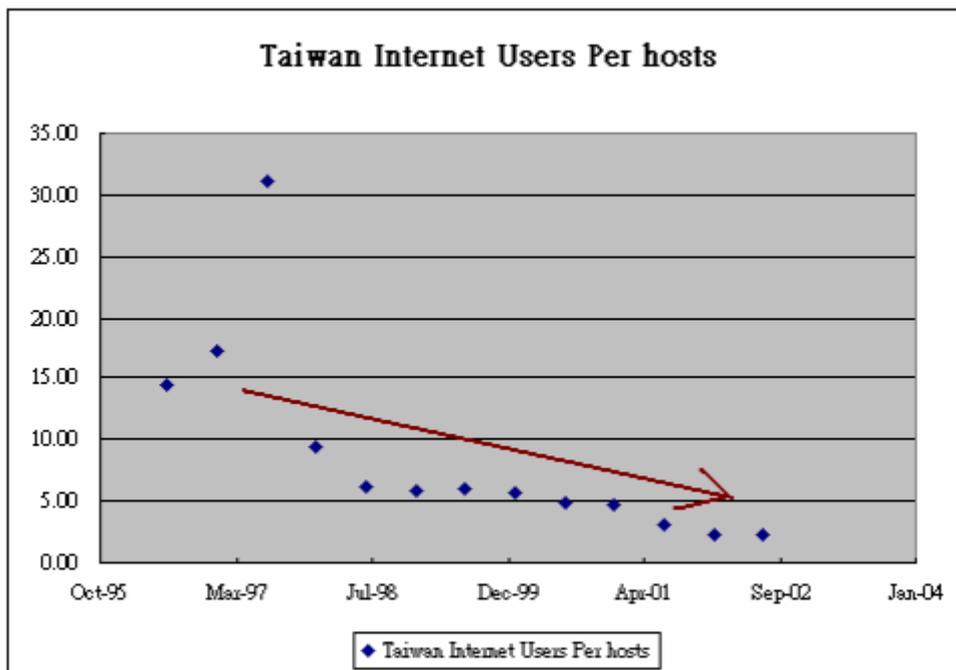


Figure 3.Taiwan Internet Users Per hosts

#### 4.3. Analysis of Dual Acceptance Model

Dual acceptance model implied that internet hosts is related to internet users and the relation of internet hosts and internet users follows a linear relationship.

Though the Correlation coefficient of Taiwan internet users and Taiwan Internet hosts appears to be a high relationship ( $r=0.9193$ ), the total number of internet hosts doesn't follow a stable linear relationship with the

total number of internet users, but follows a decreasing relationship.(Table 5, Figure 3).

Dual acceptance theory indicated the rate of adoption of web servers depends upon the number of users, not the number of internet hosts, which means more internet users, more internet hosts. But the growth rates of Taiwan internet hosts and internet users changes every period and don't follow the dual acceptance theory.

In short ,the data of Taiwan Internet users and hosts doesn't support. dual acceptance theory.

Table 5.Taiwan Internet Users per host

Time	Internet Users Per host
Jul-96	14.36
Jan-97	17.32
Jul-97	31.09
Jan-98	9.39
Jul-98	6.14
Jan-99	5.79
Jul-99	5.94
Jan-00	5.65
Jul-00	4.84
Jan-01	4.65
Jul-01	3.15
Jan-02	2.28
Jul-02	2.28

## 5. Conclusion

Although the Internet is still developing now, we couldn't get the whole picture how Taiwan internet users interact with Taiwan internet hosts. However the results of this study still prove some useful finding to the concept of the diffusion process of innovative and adopters. They are summarized as following:

### 5.1.Models of diffusion of innovations

Developing models that explain the growth process is critical for policy formulation, capacity planning and introduction new network hardware and software. Growth projection informs providers of Internet products and service of the potential consumer base.

This paper has presented that Gompertz and Logistic models could be used for forecasting regional Internet diffusion. The exponential model is only useful at early stage of diffusion of innovations. For a long-term planning, the general S curve regression model could be better fitting models.

### 5.2.Dual acceptance theory in Taiwan

In dual acceptance theory, diffusion of internet adopters depends upon internet servers whereas the diffusion of the web server depends upon internet users. The rate of adoption of web servers depends upon the number of users, not the number of internet hosts.

The Correlation coefficient of Taiwan internet users and Taiwan Internet hosts supports the relationship of Internet hosts and Internet Users.

However , the total number of internet hosts follows a decreasing relationship with the total number of internet users. The data indicated the rate of adoption of internet hosts increased faster than the rate of adoption of internet users. And this doesn't follow the study of Chen's research.

This finding implied that dual acceptance model should be modified. The dual acceptance model is a new concept which has not been sufficiently explored. Further research on the dual acceptance model is needed to expand the knowledge about on the relationship of innovative and adopters and the consequence of innovative.

## References

- [1]Chen, Hsiang, Dual Acceptance of Web Diffusion: A case of Clients and Servers.26<sup>th</sup> Annual conference of the Canadian Association for information Science.
- [2]Goodman, S.E., Press, L.I., Ruth, S.R. and Rutkowski, A.M., The global diffusion of the Internet patterns and problems. Communications of the ACM 37, 8 (Aug. 1994), 27-31.
- [3] Martino, P.Joseph.Technological Forecasting for Decision-making. McGraw-Hill Press (1994)
- [4]Press, L.Tracking the global diffusion of the Internet.Comm.ACM 40,11 (1997),11-18
- [5]Prescott, M..B , Slyke ,Craig Van, The Internet as an Innovation, the Second Americas Conference on Information Systems(1996).
- [6]Rai, A., Ravichanran, T., and Samddar, S., How to anticipate the Internet's global diffusion. Association for computing Machinery. Communications of the ACM 41, 12 (1998) 97-106.
- [7]Rogers, E. Diffusion of Innovations. Free Press, New York, N.Y., 1983.
- [8]Taiwan 2001 Internet Almanac (Chinese Edition), MOEA press, (2001) ISBN-957-01-0228-4
- [9]Williams, F.R., Rice,R.E.,and Roger,E.M., Research Methods and the New Media, New York, Free Press.

# Allying BPR with Strategy: A New Perspective for BPR

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## Abstract

Since early 1990's, Business Process Reengineering (BPR) has become a buzzword around the world. Of the BPR methods and models suggested, the majority has put much attention on redesigning processes at operational levels. Those who stress the importance of strategic process reengineering tend to emphasize that redesigning should be embarked and implemented at a broader scope (cross-functional) in order to obtain greater pay offs, whereas the impact of BPR on strategies is less studied. In this paper, we propose that BPR ally with strategies and, consequently, emphasize the importance of BPR relevant to strategies and the significant role of strategic directions in light of BPR. Thus, we develop a conceptual BPR model that links a firm's strategy, with a real world example. The main purpose of this paper is to demonstrate the inter-relationship between BPR and strategy and to help provide guidelines for better BPR implementation to enterprises.

Keywords: BPR, strategy, ally

## 1. Introduction

Since early 1990's, Business Process Reengineering (BPR) has become a buzzword around the world. Though success reports are accompanied by a list of failures, firms are still moving ahead with BPR. For example, a survey of 1,000 U.S. Chief Financial Officers expressed their enthusiasm for radical changes: over 90% of the respondents indicated that their companies would embark on new re-engineering efforts in the future<sup>[14]</sup>. In response to firms' appeal for better implementation methods, some methods and models of BPR have been suggested. By studying these methods and models we find that many of them are focused on redesigning processes at operational levels<sup>[1][4][6][8][9][11][12][15][16]</sup>. For those who stress the importance of strategic process reengineering tend to emphasize that redesigning should be embarked and implemented at a broader scope (cross-functional) in order to obtain greater pay offs<sup>[14]</sup>. Less studied are the important contributions of BPR to strategies and how strategic directions can better guide reengineering. Motivated by these shortcomings, in this paper, we investigate the importance of BPR relevant to strategies and the significant role of strategic directions in light of BPR. The main purpose of this research is to demonstrate a close relationship between BPR and strategy and to help provide guidelines for better BPR implementation to enterprises in China.

Section 2 discusses the literature review on the strategic importance of BPR. Section 3 presents a conceptual model of allying BPR with strategy. Section 4 illustrates the role of strategic directions in light of BPR. Section 5 builds the linkages between BPR and strategy. Section 6 shows a real world example. Section 7 concludes the paper.

## 2. Literature Review

Along with its great successes, BPR also has a disappointing track record. One of the BPR implementation problems is that firms do not have a proper method supporting a systematic redesign<sup>[10][13]</sup>. Many methods and models were presented to help firms redesign processes successfully. Yoon Ho Cho, Jae Kyeong Kim, and Soung Hie Kim<sup>[6]</sup> focused their attention on process simulation modeling and analysis of the simulation result (ie. process) based on a role-based concept. They believe that a business process can be defined as a combination of roles that are defined as a set of people and their accountabilities, and the interactions among them, or that a process can be defined as a series of customer-supplier relationships with desirable results at specific points in time. They introduced an object-oriented queuing model and developed a simulator, which tried to find bottlenecks of a process and to reengineer the process. The bottlenecks are regarded as roles that have higher utilization, lower process time/elapsed time ratio, and higher work allocation ratio. Ren-qian Zhang, Fa-jie Wei, Guo-ping Xia, and Si-ping Shan<sup>[11]</sup>, and Feng Zhang and Yu-liu Zhang<sup>[4]</sup> studied how to use activity-based cost (ABC) method to provide useful information in helping understand and reengineer existing business processes, in order to reduce costs. Aalst<sup>[15]</sup>, and Jian-zhong Li and Liang-qiu Chen<sup>[6]</sup> worked on a process technique: EPC (Event Process Chain) or EEPC (Extended Event Process Chain) in implementing BPR. Aalst researched on the improvement of EPC, who defined syntax and semantics of EPC by mapping EPCs (without connectors of type v) onto petri nets. Among many analysis techniques for EPCs, Jian-zhong Li and Liang-qiu Chen<sup>[6]</sup> established EEPC model to help identify problems of the exist processes and reengineer them. To adopt EPC models, K-H Kim and Y-G Kim<sup>[8]</sup> developed EPRE (enterprise process reverse engineering) process modeling and redesign method, which consists of the following three stages: 1) to analyze form: to define forms and form fields, and to identify field set operations with field type; 2) to generate process model: to generate EPC diagram; and 3) to redesign process: to redesign intra-FSO (Field Set

Operation defined as a set of activities which processes one or more form fields and is performed at a single location during a single session for a specific customer service) and to redesign inter-FSO. Their process redesign support is restricted to information handling activities. Soung-Hie Kim, Ki-Jin Jang<sup>[12]</sup>, and Brane Kalpic and Peter Bernus<sup>[1]</sup> worked on another process technique: IDEF0. Soung-Hie Kim and Ki-Jin Jang discussed the application of IDEF0 tools to implement the process modeling and performance capabilities. They presented a framework to support analysis of activities and information flows within the scope of manufacturing application. Their effort was to coordinate information flow for activities, to enhance requirement reconfiguration, and to minimize errors and the unplanned evolution of activities in BPR project executions. Brane Kalpic and Peter Bernus utilized the functional modeling language IDEF0 to reengineer the processes of new products development. They followed a simple three-step method of BPR: 1) description phase of a business process, 2) analysis phase that focused on the investigation of facts and characteristics of existing process, and 3) redesign phase where the process model was redesigned based on the findings of the analysis phase and predefined objectives. They stressed the important role of modeling and analysis of functional structure in process reengineering. M. Abdomerovic, and G. Blakemore<sup>[9]</sup> focused attention on analyzing process variables in order to discover project process interactions. They argued that understanding project process interactions would help define what influences project results, and discovering factors that influence project results would lead to improvement of the existing processes. For this reason, they believed that the design of project process interaction can serve as a project process reengineering tool. There are other models and methods for BPR implementation: S. Guha's Life Cycle methodology, T. Davenport's framework of process reengineering, R.b. Kaplan's core process redesign, Gateway Company's Rapid Re Method<sup>[7]</sup> and method provided by Richard J. Mayer in KBSL (Knowledge Based Systems Inc.) incorporation<sup>[17]</sup>.

By studying these models and methods, we see that their methods or models do not deviate the theme that consists of: first understanding the existing process, and then identifying and eliminating the problems of the existing process. William J. Kettinger and James T. C. Teng<sup>[14]</sup>, who stressed the importance of strategy in process reengineering, emphasized much on the idea that embarking of BPR should be at a higher level (cross-functional) instead of a lower level (intra-functional) in order to obtain higher pay offs. Most of them had same hypothesis that the existing strategy is appropriate and need not be examined. They emphasized their study more at the operational level than at the strategic level. But the fundamental question is: when we reengineer processes, does strategy really matter?

### 3. The Strategic Place of BPR

BPR is defined by Doctor Hammer and Champy as "the fundamental rethinking and radical redesign of business

processes to achieve dramatic improvements in critical, contemporary measures of performance such as cost, quality, service and speed."<sup>[5]</sup> In their terms, BPR is characterized as a "clean sheet" approach that starts from fundamental rethinking. As time passes, redesign from clean sheet is improved and modified. Some scholars feel that the clean sheet redesign is not feasible in reality. Process improvement and process innovation are presented. But one core of BPR: "fundamental rethinking" presented by Hammer and Champy was universally accepted by scholars and entrepreneurs. Fundamental rethinking requires that people rethink about such fundamental questions as to why an enterprise should do what it is now doing, what resources it owns, what it is going to achieve in the future and how to achieve the goal effectively and efficiently. BPR tries to change an enterprise through process changes to let the enterprise fit the business environment. Therefore, BPR in fact requires that an enterprise stand at the height of the strategic level to re-examine its processes: what it is doing, what resources it owns, what changes it makes to the environment, and why it should do what it is doing to help either create a new value source or to enhance the existing competence. For example, Wiltel<sup>[3]</sup> is traditionally a natural gas pipe company. When they were faced with such basic questions as "What do we actually own?" they found that they actually owned utility rights of pipes and nation wide roads. After rethinking how they can make most effective use of these resources and what are the benchmarks in the industry, they made an innovation by providing new optical fiber cables in order to full making use of the existing establishment. Consequently, they are able to compete with such major telecom companies as MCI and AT&T. Their rethinking at the strategic level created a new value source. Reebok and Compaq are other examples of enhancing competence through re-thinking on their fundamental issues. Reebok raised the basic question "Why should we make shoes?" This rethinking helped Reebok realize that making shoes is not pivotal to company. As a result, they shifted their attention from production processes to design and marketing<sup>[3]</sup>. Likewise, Compaq decreased their production of terminal products by 30% and concentrated on marketing and R&D<sup>[3]</sup>. Re-thinking on a company's core business ensures that the company does the right things, which is considered the corner stone of BPR.

BPR must start from rethinking a firm's basic business model is obliged by customer needs and ever-changing business environment. Customers care more on service results than on production processes although service results are the product of production processes. In fact, production processes determine the service results, and the service results in turn guide the directions in improving the production processes. An enterprise must change its business processes for better service results required by its customers, through such BPR as enlarging, shrinking, or abandoning its production processes. According to the Economist Intelligence Unit, 57% of the companies surveyed claim that they have experienced profound innovation in the past five years, and 79% of the subjects anticipate that they would

launch a profound innovation by year 2010<sup>[3]</sup>. Companies that do not change to enhance competitiveness will fail and competence increases should not be limited within the industry. An enterprise must increase competence not only to survive, but also to thrive in the global marketplace. Having the right direction to implement BPR is by far the most important thing for any company to ensure. Otherwise, the enterprise will fail the competition even if it has excellent processes. Therefore, that a firm should re-think why it should do what it is doing and what it should do is the first priority of business process reengineering.

Before entering into real estate industry in Hong Kong, a well-known entrepreneur, Jia-cheng Li, was successful in plastic flower production with the nickname “king of plastic flower.” Li was good at asking himself what he should do. Re-thinking the basic question made him change his business directions at the right timing. Instead of continuously increasing the competence in the industry he shrank his plastic flower production business and began investing in real estate, which proved to be a correct strategic change<sup>[18]</sup>. Similarly, Wen-han Liu, another famous entrepreneur in Hong Kong, was once called “Father of Hairpiece.” He also changed his business orientation from hairpiece production to a new industry at the right time by asking himself what he should do. Rethinking the strategy prevented him from a possible failure when customers’ enthusiasm in hairpiece decreased<sup>[18]</sup>.

#### 4. The Role of Strategy in BPR

To embark process reengineering, a BPR project must be guided by strategy. There are three most important roles of strategy in business process reengineering.

First, BPR under strategy will ensure that process reengineering increases the company’s competence, and avoid the possibility of performance increase in part but hurt in the whole. For example, one big American insurance company transfers human and technology resources from an investment management process to a new insurance policy issuing process. Though the latter has been improved, the reengineering hurts the performance of the estate investment, which contributes to its bankruptcy<sup>[3]</sup>.

Second, business strategies guide the dimensions of the reengineering with four possible options: value creation, cost reduction, quality improvement, and cycle time reduction. In the past, BPR was often linked only with cost reduction and staff reduction. However BPR can do more. For example, when high-risk drivers were rejected by other insurance companies, Progressive Insurance<sup>[1]</sup>, the ninth-largest auto insurer in the USA decided to create a new value source. They re-generated the underwriting process to make it more detailed and more precise than that of their competitors, which led to a very precise price decision. When their competitors began imitating, they changed their

reengineering focus to quality improvement. It reengineered their claim process by exploiting a technique called “immediate response.” Now, Progressive can dispatch an adjuster to examine a claimant’s car on the day of the accident - in many cases, going to the accident site themselves. Guided under a strategic rethinking, its BPR helped Progressive poach on new territory and increased customer satisfaction and, as a result, increased competitiveness. Example of cycle time reduction can be found with Kodak, where it reduced its research cycle time of 35mm focus camera from 70 weeks to 38 weeks<sup>[5]</sup>.

Third, strategies can help define the reengineering scope and select processes by means of three different levels: company strategy, business unit strategy, and function strategy. The company level strategy guides the business unit strategy and the business unit strategy, in turn, guides the function strategy. The company strategy includes vision or mission statements as well as goals and objectives. Vision or mission statements delineate the directions an organization wants to pursue or avoid. Goals and objectives can cascade down from mission statements, which are usually more specific and quantitative. There are a wide range of strategic tools, including mission statement, competitive intelligence, environmental scanning, technology assessment, portfolio matrices, SWOT, core competence, value chain, scenario analysis, stakeholder mapping, market value addition (MVA), and economic value addition (EVA). Different levels of strategies and various strategic tools can help determine the reengineering scope, select the reengineering processes, and help set definite and clear reengineering goals that are essential for BPR. For example, when Belgium Communication<sup>[3]</sup> found that improving the company’s image is vital for the future development, it selected two critical processes for reengineering – the supply process and the maintenance process, which had close connection with its customers.

#### 5. Allying BPR with Strategy

Figure 2 shows a conceptual model for reengineering, as opposed to traditional models summarized in Figure 1. Table 1 compares the traditional and the conceptual new models to highlight the differences and commonalities. It is seen from Table 1 that the traditional models focus more on the selection of the processes and tools for reengineering under the guidance of strategies, whereas the conceptual new model emphasizes on the re-examination of organizational strategies on the basis of understanding their business environment and value-added processes. In other words, the more a firm understands the existing processes, the more it helps understand its potential resources relevant to the global business environment.

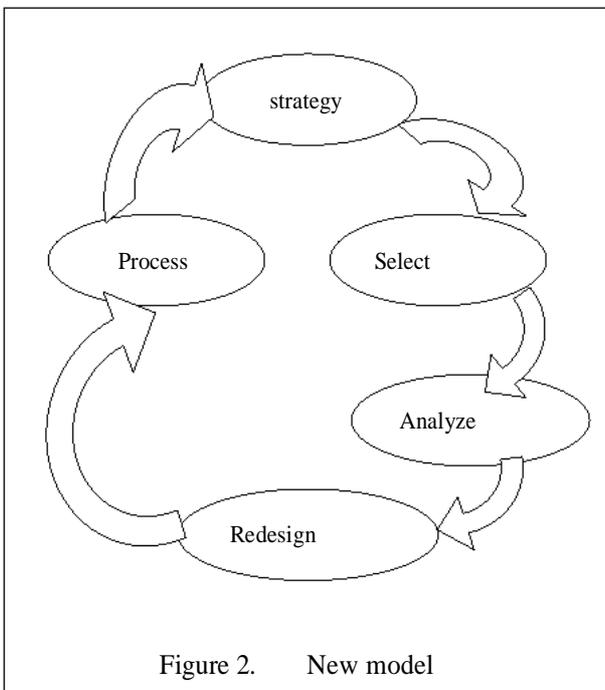
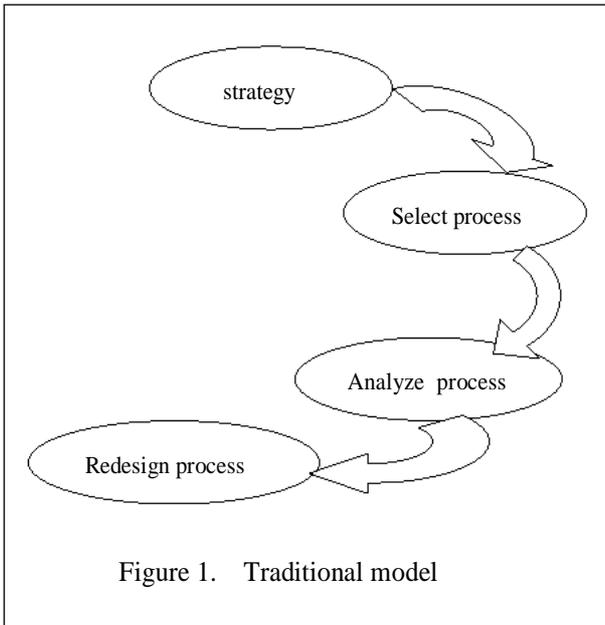


Table 1. Difference between the Traditional and the New Models

	Traditional Model (Figure 1)	New Model (Figure 2)
Hypothesis	The existing strategy need not be re-examined.	The existing strategy need be re-examined.
Start Point	Understand existing strategy.	Rethink about the basic question of the company.
Basic Question	How can process be better implemented?	Why process should exist? Then how can

to Answer		process be better implemented?
Focus	Establish various models to help identify problems of existing process and redesign new process.	Not only concern establishing various models but also concern how to cascade strategy to definite and clear goals to guide BPR.

## 6. An Example

Without loss of generality, let us consider XYZ, a subsidiary of a big American IT company, as an example. This company was established in China in 1999 with its headquarters in Hong Kong. It has staff over 600 and has established branch offices in 24 major cities in China. When they decided to embark reengineering, they did the following:

First, XYZ analyzed its six business lines: 1) system product, 2) net product, 3) product component, 4) consumption product, 5) engineering solution, and 6) electronic commerce. XYZ divided its products and services into two types: low value-added products and high technology, high value-added services.

Second, XYZ classified its customers into three groups - retailers, distributors, and service suppliers who provide the system with high value-added services - including such companies as Haier, Changhong, Nokia, First Department Store of Shanghai, Beijing Modern Shopping Center, China Software, Tide.

In doing so, XYZ found that their business lines were long and diversified. Further analysis showed that long and diverse business lines resulted in high level of inventory stock. Sometimes monthly turnover was only ¥ 30,000,000, but stock occupied capital over ¥ 130,000,000.

Third, XYZ identified its main competitors and finished SWOT analysis. Through benchmarking, it realized the gap between XYZ and its main competitors: it sold a big portion of low value-added commodities, whereas the proportion of high technology, high value added services were low. Moreover, XYZ felt that it needed to pay much more attention in establishing its brand name.

Fourth, XYZ analyzed the internal production capability and facilities.

Thus, the company re-aligned its mission statements and differentiated itself as the best supplier of scientific and technological products in the world. Consequently, it delivered the biggest benefits to its stakeholders and, at the same time, modified its goals and objectives in accordance with its mission. For future development, they decided that they should establish its brand name recognition, and that they should raise the turnover ratio of high value added services and products and change their marketing from sales promotion to customer satisfaction. In light of its mission and objectives, XYZ chose the marketing process as its reengineering focus. They set the reengineering target as integrating marketing oriented capital resources and

strengthening macro-control ability to help achieve this objective. Sub-targets were determined through further analysis and six sub-processes were redesigned. As of today, XYZ is one of the most successful companies in the industry in Hong Kong, as well as in the world.

## 7. Conclusion

BPR is an essential and effective endeavor for enterprises to increase their competitiveness and to thrive in the global marketplace. Since speed of change is faster and faster nowadays, BPR must ally with strategies. First, BPR must start with rethinking on an enterprise's strategic issues. That is, it should start BPR at the strategic level by asking such fundamental questions as what are we doing, what do we have, and why should we do what we are doing. Starting at such a strategic level will ensure that the enterprise is advancing in the right directions. Second, BPR must be guided by strategies, which will ensure that BPR increases the enterprise's competence as a whole, instead of increasing performance in one part but hurting as a whole. In order for strategies to better guide BPR, they must be cascaded into definite, clear, and specific objectives and sub-objectives. Since strategy management can be classified into the category of management research, the interfaces between strategy management and BPR is a direction for future research, which may help answer such questions as how to depose higher level of strategies into more specific and clearer goals and objectives of BPR implementation.

## Acknowledgement

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## Reference

- [1] Brane Kalpic and Peter Bernus. "Business Process Modeling in Industry - The Powerful Tool in Enterprise Management." *Computers in Industry*, Vol. 47, pp. 299-318, 2002.
- [2] Colin Armistead, Jean-Philip Pritchard, and Simon Machin. "Strategic Business Process Management for Organizational Effectiveness," *Long Range Planning*, Vol. 32, No.1, pp. 96-106, 1999.
- [3] The Economist Intelligence Unit. *Vision 2010: The Learning Organization, Building Process Excellence* (in Chinese), Xinhua Press, pp. 4-9, Beijing: 2000.
- [4] Feng Zhang and Yu-liu Zhang. "Application of ABC Method in BPR (in Chinese)," *Jtsinghua University (Science & Technology)*, Vol. 40, No.9, 2000.
- [5] Hammer M. and Champy J. *Reengineer the Corporation: A Manifesto for Business Revolution*, Nicholas Brealey Publishing, London: 1993.
- [6] Jian-zhong Li and Liang-qiu Chen. "Application of Extended Event Process Chain (EEPC) in BPR (in Chinese)," *Systemic Engineer*. Vol. 18, No. 1. Jan. 2000.
- [7] Jian Ma and Li-hua Huang. *Business Process*

*Reengineering/Improvement - Concept and Application* (in Chinese), pp. 71-93. Joint Publishing Co., Ltd., Hong Kong: 1998.

- [8] K-H Kim and Y-G Kim. "Process Reverse Engineering for BPR: A Form-based Approach," *Information & Management*, Vol. 33, pp.187-200, 1998.
- [9] M. Abdomerovic and G. Blakemore. "Project Process Interactions," *International Journal of Project Management*, Vol. 20, pp. 315-323, 2002.
- [10] M.G. Martinsons. "Radical Process Innovation Using Information Technology: The Theory, the Practice and the Future of Reengineering," *International Journal of Information Management*, 15(4), pp. 253-269, 1995.
- [11] Ren-qian Zhang, Fa-jie Wei, Guo-ping Xia, and Si-ping Shan. "ABC Analysis in Business Process Reengineering (in Chinese)," *Industrial Engineering Journal*, Vol. 3, No.4. Dec. 2000.
- [12] Soung-Hie Kim and Ki-Jin Jang. "Designing Performance Analysis and IDEF0 for Enterprise Modeling in BPR," *International Journal of Production Economics*, Vol. 76, pp. 121-133, 2002.
- [13] T.H. Davenport. *Process Innovation: Reengineering Work Through Information Technology*, Harvard Business School Press, Boston: 1993.
- [14] William J. Kettinger and James T. C. Teng. "Aligning BPR to Strategy: A Framework for Analysis," *Long Range Planning*. Vol.31, No.1, pp.93-107, 1998.
- [15] W.M.P. van der Aalst. "Formalization and Verification of Event-driven Process Chains," *Information and Software Technology*, Vol. 41, pp. 639-650, 1999.
- [16] Yoon Ho Cho, Jae Kyeong Ki Soung Hie Kim. "Role-based Approach to Business Process Simulation Modeling and Analysis," *Computers & Industrial Engineering*, Vol. 35, Nos. 1-2, pp.343-346, 1998.m, and
- [17] Yu-liu Chen, Oing Li, and Feng Zhang. *Business Process Reengineering and Systems Integration* (in Chinese), Tsinghua University Press and Springer Press, pp.12-52, Beijing: 2001.
- [18] Yu-wen Ma. *Jia-cheng Li's Business Wisdom to Grow from Small to Big* (in Chinese), China Commercial Press, pp137-141, Beijing: 2001.

# Optimal Online Interactive Service Policy and Pricing Decision with Negative Network Externalities

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## Abstract

In online interactive service industries, customers' utility is mainly from the service received but it is also affected by other customers' annoying behavior. Annoying behavior is configured to increase the utility of externality-loving customers who do it but on the contrary reduce the utility of externality-hating customers.

This paper proposes the optimal online interactive service policy and pricing decision in three sections. First, "forbiddance" policy is the norm. Second, "allowance" policy is the norm. Third, "forbiddance" policy is partially expected.

The results contradict to some intuitions. First, intuition may tell us that negative externality is harmful to customers' utility and service provider's revenues. Thus, it is favorable to eliminate the externality. In this paper, "forbiddance" policy that eliminates the annoying behavior is not always optimal. When the externality-loving segment is large enough, it's optimal to adopt "allowance" policy to delight this segment.

Second, intuition may tell us meeting the preference of the majority of customers brings the most revenues. In this paper, the intuition may guide to the wrong way especially when "forbiddance" policy is the norm. Besides, we propose three simple decision support figures for service providers.

(Keywords : Internet Marketing; Electronic Commerce Management; Service Operations on the Web; Network Externality)

## 1. Introduction

### 1.1 Externalities in Online Interactive Service Industries

Online interactive services include at least online games, online auctions, and online chat rooms. In these industries, the customers' utility is mainly from the online interactive service received but the presence or behavior of other customers in the same system will affect it [8] [12]. In online games, chatting answers of quests may reduce other players' fun in quest solving. In online auctions, exaggerate overpricing may waste potential buyers' time. In online chat rooms, commercially personal selling may waste users' time if they are not interested. The utility change due to other customers' presence or behavior is called "externality" other customers bring.

Customers may bring positive [9] [12] or negative [8] [12] [14] [16] externalities into the system through various ways. For example, signals of quality, utility of communication [9], congestion [16], competition for resources [14], presence of different social classes [8], or intergroup utility piracy [4]. All means above could alter customers' utility and decision by presence of another individual or another group of customers.

### 1.2 Literature Review

The term "network externality" is generally recognized after the works of [4] and [9]. Network externality in nature is the externality result from equivalent adoption decisions by other customers [4] [9].

The literature of network externality could be categorized into three parts. Economists firstly focus on the positive and direct network externality. Second, the positive and indirect network externality also attracts some attention [1] [2]. Third, the literature [8] that discussed about negative network externality is rather little. In sum, the literature in Economics largely focused on social welfare and less emphasizes the managerial implications than the literature in Management Sciences.

Literature in Management Sciences focuses on negative network externalities. If the service provider ignores the congestion externality, the problem of unexpected congestion may emerge. The utilization rate may deviate from optimality [16].

Besides, Metcalfe's Law should be modified, because the utility of each link between customers may not always be symmetric, positive, and even existing. One trial shows that the monopolistic system owner may overprice, overestimate revenues, and wrongly focuses on too more customers with negative network externality ignored [4]. Generally speaking, network externalities are far less studied in Management Sciences.

### 1.3 The Purpose of This Paper

This paper aims to find the optimal online interactive service policy (to forbid or to allow) and pricing decision with the existence of forbidable annoying behavior in three sections (Section 3, 4, and 5). First, "forbiddance" policy is the norm. Second, "allowance" policy is the norm. Third, "forbiddance" policy is partially expected.

This paper also examines two intuitions. First, intuition may tell us that negative externality is harmful to customers' utility and service provider's revenues. Thus, it is favorable to eliminate the externality. Second, intuition may tell us meeting the preference of the majority of customers brings the most revenues.

The first intuition obviously undervalues the externality-loving customers. When externality-loving customers are willing to pay a higher price, it's possibly more favorable to accommodate externality-loving customers only.

The second intuition neglects the alternative only serving a smaller group of customers. The alternative may generate more revenues when the group alone can fill the capacity completely and pay a higher price for preferred policy (forbiddance to externality-hating customers and allowance to externality-loving customers).

#### 1.4 The Importance of The Topic

The topic is rather important in industries such as online games, online auctions, and online chat rooms, because various behaviors may create externality in customers' interactions. For example, exaggerate overpricing in online auctions may waste potential buyers' time and greatly reduce their utility and then affect their choices among similar service providers. Furthermore, should the online interactive service provider allow the occurrence of annoying behavior or forbid that? It's an interesting problem not solved yet but contributes a lot to practitioners' decision making.

#### 1.5 Comparison with Past Literature

Compared with past literature, the paper configures that there are two groups of customers having different quality recognition and that is different from only one group of customers having same quality recognition [10]. Models including different tastes may describe the reality more precisely.

The externality-loving customers may cause no externality (to externality-hating customers) if they are forbidden to do the annoying behavior. That is different from externality due to other customers' presence [14] [16]. The configuration in this paper is proper to describe marketing situations.

The externality-loving customers were once treated as "pests" and they generate rather few revenues to service provider [4]. In this paper, the externality-loving customers were treated as normal customers generating the same revenues as externality-hating customers if no annoying behavior real takes place.

The paper points out a new source of negative externality among customers: annoying behavior. That is, the externality is accompanied with the annoying behavior of the externality-loving customers. In online games, the answer-chatting customers may reduce other quest-solving customers' fun. The externality does not come from the presence of the answer-chatting customers, but from the annoying behavior "chatting the answer" they do.

The issue of optimal policy and pricing decision is rarely addressed in the past literature.

#### 1.6 The Organization of the Paper

The remainder of the article is organized in five sections. Section 2 describes the model. Section 3 analyzes the optimal policy and pricing decision when

forbiddance is the norm. Section 4 analyzes the optimal policy and pricing decision when allowance is the norm. Section 5 is the generalization of Section 3 and 4. Then conclusion and future research opportunities are drawn.

## 2. Model

### 2.1 Online interactive service System and Customer Segmentations

The online interactive service provider is configured as a monopolist. This paper segments the customers into two groups. One group is composed of externality-hating customers who are represented as A-group customers and the other group is composed of externality-loving customers who are represented as B-group customers.

### 2.2 Price and Utility

The online interactive service provider only can set a single price toward two groups of customers and simultaneously set the policy (to forbid or to allow). Every customer's utility is zero if he (she) chooses not to join in the online interactive service system. Implying that every customer would join in the system if and only if his (her) utility could be nonnegative in the online interactive service system. Every customer joining in the system obtains utility (represented by  $S$  in the model) and pays the price (represented by  $P$  in the model).

Many factors may be considered and expected by customers [11] but the paper addresses utility change due to forbiddance or allowance of annoying behavior. "Desired" and "adequate" are two service levels [17]. The former is the satisfactory level and the latter is not-dissatisfactory level. Based on the two concepts, three sections and corresponding configurations are described:

In Section 3, "forbiddance" is the norm. B-group customers treat "forbiddance" as adequate and treat "allowance" as desired. Therefore, B-group customers obtain additional utility (denoted by  $E$ ) doing annoying behavior under the "allowance" policy. Analysis is done in Section 3.

In Section 4, "allowance" is the norm. B-group customers take "allowance" as adequate. Therefore, no additional utility would be received since annoying behavior is not a privilege but taken for granted. On the contrary, B-group customers would lose some utility (denoted by  $E$ ) if the annoying behavior were forbidden. Analysis is done in Section 4.

In Section 5, "forbiddance" policy is adopted by only a part of the industry and the remaining part set "allowance" policy. B-group customers may set a reference point between "forbiddance" and "allowance" policies. To be more specific, B-group customers obtain additional utility (denoted by  $e_1$ ) facing "allowance" policy and lose utility (denoted by  $e_2$ ) facing "forbiddance" policy. Analysis is done in Section 5.

Here,  $(e_1 + e_2)$  is assumed to be equal to  $E$  because the same behavior offers the same utility (denoted by  $E$ ) to B-group customers regardless of the norms of the industries. The configurations of three sections are showed in Table I.

**Table 1 : Configuration of three sections**

Utility Policy Section	B-group customers' utility		A-group customers' utility	
	Forbiddance	Allowance	Annoying behavior takes place	Otherwise
Section 3	S	S+E	$S - N * N_n$	S
Section 4	$S - E$	S	$S - N * N_n$	S
Section 5	$S - e_2$	$S + e_1$	$S - N * N_n$	S

For example, there are 3 B-group customers doing annoying behavior in the system and every A-group customer's utility is  $S - P - 3N_n$  and every B-group customer's utility is  $S - P + E$  (under the setting of Section 3). The utilities from different sources are additive and that is common in model configurations [7] [13].

**2.3 Notations and Variables**

- Notations used in the model are as follows:
- S: every customer's utility from the online interactive service system
- E: the utility difference between to do and not to do annoying behavior for any B-group customer
- $N_n$ : the utility reduction for any A-group customer facing per B-group customer doing annoying behavior
- M: the number of A-group customers
- N: the number of B-group customers
- P: the single price charged to every customer
- C: the capacity of the online interactive service provider
- FO: the policy "forbiddance"
- AL: the policy "allowance"

Section 3, 4, 5 manipulate the utility addition and subtraction those due to forbiddance or allowance of can/cannot doing annoying behavior for B-group customers. The policy and price set by the online interactive service provider are decision variables and the "join-or-not" decisions made by customers are endogenous variables. The revenue received by the online interactive service provider is the main dependent variable.

S, E,  $N_n$  are given positive numbers and M, N, C are given positive integers. Furthermore, P is restricted to be positive.

If the customers choose in sequence, then  $A_i$  is denoted to the  $i^{th}$  customer choosing in A-group customers and  $B_j$  is denoted to the  $j^{th}$  customer choosing in B-group customers.

**2.4 Procedure of the Events**

The scenarios to be discussed all follow the same procedure of the events:

First, the online interactive service provider sets the behavior policy as "forbiddance" or "allowance" and meanwhile sets a single price to every customer.

Second, all B-group customers as a whole choose whether to join the service system or not. (This could be relaxed at 2.5)

Third, all A-group customers as a whole choose whether to join the service system or not. (This could be relaxed at 2.5)

Fourth, all customers obtain the utility they perfectly expect and the service provider collects the revenues.

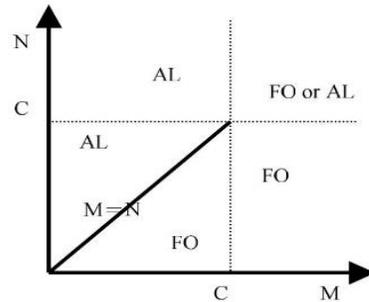
**2.5 The Irrelevance of Choice Sequence among Customers**

In 2.4, B-group customers are assumed to choose simultaneously and make the same decision. After B-group customers' choices, A-group customers are assumed to choose simultaneously and make the same decision.

In 2.5, we prove that same-group customers all make the same decision (to join or not) under any choice sequence in Appendix.

**2.6 Intuition to be Examined**

In intuitions, the online interactive service provider should meet the preference of the majority. When each segment alone can fill the capacity completely, meeting preference of either one segment is equally optimal. Figure 1 illustrates the thinking.



**Figure 1 : The optimal policy in intuition**

In Figure 1, 2, 3, and 4, "AL" is assigned when the optimal policy is "allowance" and "FO" is assigned when the optimal policy is "forbiddance". "FO or AL" is assigned when both policies are equally optimal.

**3. "Forbiddance" Policy is the Norm**

In online games, online auctions, and online chat rooms, most service providers forbid cheating and threatening. Every customer knows the norm and takes "forbiddance" policy as granted.

B-group customers thus obtain "normal" utility (denoted by S) without doing the behavior they love, but B-group customers' utility may increase (denoted by E) if they are permitted to do the behavior.

In this setting, every B-group customer's utility is always no less than every A-group customer's utility. This is tabularized in Table 2.

**Table 2 : The utility settings in Section 3**

Utility Policy Group	Forbiddance	Allowance	
		With B-group	Without B-group
A	S	$S - N * N_n$	S
<b>B</b>	<b>S</b>	<b>S + E</b>	

Since every B-group customer's utility is always no less than every A-group customer's utility, it's impossible

only to attract A-group customers through behavior policy and pricing decision. This is proved in Lemma 3.

*Lemma 3 :*

When “forbiddance” is the norm, the online interactive service provider cannot only attract A-group customers only through behavior policy and pricing decision.

**Proof:**

According to Table 2, it’s obvious that under any policy the reservation price of B-group customers is always no smaller than the reservation price of A-group customers. Thus, no price exceeds the reservation price of B-group customers but at the same time not exceeds the reservation price of A-group customers. Lemma 3 is proved.

With Lemma 3 proved, the online interactive service provider should treat B-group customers as the main segment and try to serve them in the first priority.

Because the sizes (denoted by M, N) of two groups of customers and the capacity (denoted by C) of the online interactive service provider are relevant factors in decision-making, three scenarios incorporating the factors are presented in Table 3 and guide the following analysis.

**Table 3 : The parameter settings in Section 3**

Scenario 1	$N \geq C$ and $M + N \geq C$
Scenario 2	$N < C$ and $M + N \geq C$
Scenario 3	$N < C$ and $M + N < C$

### 3.1 Scenario 1 : $N \geq C, M + N \geq C$

In scenario 1, the capacity could be filled completely only by B-group customers. Thus, the online interactive service provider should adopt “allowance” policy to meet B-group customers’ preference and charge them a higher price.

*Theorem 1 :*

When “forbiddance” is the norm and  $N \geq C$ , the optimal policy is “allowance” and the optimal price is  $P = S + E$ .

**Proof:**

When “allowance” policy is adopted, the price can be set at  $P = S + E$ , which is the reservation price of B-group customers. The system could only attract B-group customers to completely fill the capacity. Thus, the revenues would be  $C*(S + E)$ .

When “forbiddance” policy is adopted, the price can be set at  $P = S$ , which is the minimum of the reservation prices of both groups of customers. The system could attract both groups of customers to completely fill the capacity. Thus, the revenues would be  $C*S$ .

For  $C*(S + E) > C*S$ , the optimal policy is “allowance” and the optimal price is  $P = S + E$ . Theorem 1 is proved.

The managerial implication of Theorem 1 is further discussed. When B-group customers alone can

completely fill the capacity, the online interactive service provider should only meet B-group customers’ preference and charges them a higher price for the policy they prefer.

### 3.2 Scenario 2 : $N < C, M + N \geq C$

In scenario 2, the capacity could *not* be filled completely by only B-group customers, but could be filled completely by two groups of customers. Thus, the online interactive service provider should set the price to balance the additional revenues from attracting A-group customers and the additional loss from lowering price to attract A-group customers.

*Theorem 2.1*

Under the setting “forbiddance” is the norm and  $N < C$  and  $M + N \geq C$ . When  $N > \frac{CS}{S + E}$ , the optimal policy is “allowance” and the optimal price is  $P = S + E$ .

*Theorem 2.2*

Under the setting “forbiddance” is the norm and  $N < C$  and  $M + N \geq C$ . When  $N < \frac{CS}{S + E}$ , the optimal policy is “forbiddance” and the optimal price is  $S$ .

**Proof:**

When “allowance” policy is adopted, the price can be set at  $P = S + E$ , which is the reservation price of B-group customers. The system could only attract B-group customers to fill part of the capacity. Thus, the revenues would be  $N*(S + E)$ .

When “allowance” policy is adopted, the price can be set at  $P = S - N*N_n$ , which is the minimum of the reservation prices of both groups of customers. The system could attract both groups of customers to completely fill the capacity. Thus, the revenues would be  $C*(S - N*N_n)$ .

When “forbiddance” policy is adopted, the price can be set at  $P = S$ , which is the minimum of the reservation prices of both groups of customers. The system could attract both groups of customers to completely fill the capacity. Thus, the revenues would be  $C*S$ .

For  $C*S > C*(S - N*N_n)$ , the optimal policy and pricing decision only depends on whether  $C*S$  is larger than  $N*(S + E)$ .

If  $N > \frac{CS}{S + E}$ , the optimal policy is “allowance” and the optimal price is  $P = S + E$ . Theorem 2.1 is proved.

If  $N < \frac{CS}{S + E}$ , the optimal policy is “forbiddance” and the optimal price is  $P = S$ . Theorem 2.2 is proved.

When the size (denoted by N) of B-group customers is smaller than the capacity (denoted by C), Theorem 2 may apply. The optimal policy and pricing decision could be judged by comparing the gain from attracting more customers (M of A-group customers) and the loss from

lowering price to attract the additional customers. When the gain is larger than the loss, it's optimal to set policy as "forbiddance" and set the price  $P = S$  to attract both groups of customers. Otherwise, it's optimal to set policy as "allowance" and set the price  $P = S + E$  only to attract B-group customers even the capacity is only partially filled.

### 3.3 Scenario 3 : $M < C, N < C, M + N < C$

In scenario 3, the size of the whole market is below the capacity. As a result, each group of customers cannot completely fill the capacity.

#### Theorem 3.1

Under the setting "forbiddance" is the norm and  $M + N < C$ . When  $M * S < N * E$ , the optimal policy is "allowance" and the optimal price is  $P = S + E$ .

#### Theorem 3.2

Under the setting "forbiddance" is the norm and  $M + N < C$ . When  $M * S > N * E$ , the optimal policy is "forbiddance" and the optimal price is  $P = S$ .

Proof:

When "allowance" policy is adopted, the price can be set at  $P = S + E$ , which is the reservation price of B-group customers. The system could only attract B-group customers to fill part of the capacity. Thus, the revenues would be  $N * (S + E)$ .

When "allowance" policy is adopted, the price can be set at  $P = S - N * N_n$ , which is the minimum of the reservation prices of both groups of customers. The system could attract both groups of customers to fill still only part of the capacity. Thus, the revenues would be  $(M + N) * (S - N * N_n)$ .

When "forbiddance" policy is adopted, the price can be set at  $P = S$ , which is the minimum of the reservation prices of both groups of customers, to attract both groups of customers to fill still only part of the capacity. Thus, the revenues would be  $(M + N) * S$ .

For  $(M + N) * S > (M + N) * (S - N * N_n)$ , the optimal policy and pricing decision only depends on whether  $(M + N) * S$  is larger than  $N * (S + E)$ .

When  $M * S < N * E$ , the optimal policy is "allowance" and the optimal price is  $P = S + E$ . Theorem 3.1 is proved.

When  $M * S > N * E$ , the optimal policy is "forbiddance" and the optimal price is  $P = S$ . Theorem 3.2 is proved.

Theorems 3.1 and 3.2 have their managerial meaning. If the gain were larger than the loss, "allowance" policy would be optimal. Otherwise, "forbiddance" policy would be optimal.

The analytical result of Theorem 1~3.2 are combined to form Figure 2.

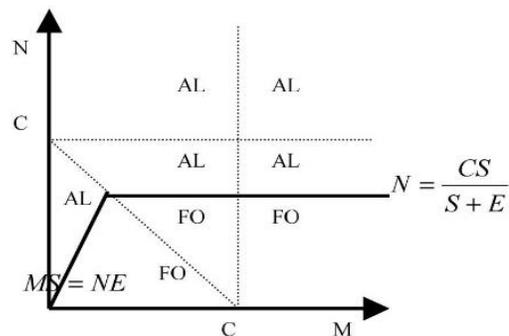


Figure 2 : The optimal policy when "forbiddance" policy is the norm

Comparing Figure 2 with Figure 1, it's surprising that the policy and pricing decision made by intuition could deviate from optimality when  $M > C$  or  $N < C$ .

## 4. "Allowance" Policy is the Norm

In online games, online auctions, and online chat rooms, most service provider allow customers idle and not respond to others' inquiry. Every customer knows the norm and takes "allowance" policy as granted.

Now B-group customers treat "allowance" policy as the baseline and the right they own. Therefore, B-group customers' utility drops to  $S - E$  facing "forbiddance" policy. Thus, B-group customers' utility is no less than A-group customers' utility facing "allowance" policy, but B-group customers' utility is less than A-group customers' utility facing "forbiddance" policy. The utility setting is tabularized as Table 4.

Table 4 : The utility settings in Section 4

Utility Policy Group	"Forbiddance" policy	"Allowance" policy	
		With B-group customers	Without B-group customers
A	S	$S - N * N_n$	S
B	$S - E$	S	

Five scenarios, which regard the relative sizes of  $M$  and  $N$  and  $C$ , are analyzed to find the optimal policy and pricing decision. Table 5 could illustrate the settings of five scenarios.

Table 5 : The parameter settings in Section 4

Scenario	Parameter Settings
Scenario 1	$M \geq C, N \geq C, \text{ and } M + N \geq C$
Scenario 2	$M \geq C, N < C, \text{ and } M + N \geq C$
Scenario 3	$M < C, N \geq C, \text{ and } M + N \geq C$
Scenario 4	$M < C, N < C, \text{ and } M + N \geq C$
Scenario 5	$M < C, N < C, \text{ and } M + N < C$

### 4.1 Scenario 1 : $M \geq C, N \geq C, M + N \geq C$

In scenario 1, each group of customers alone can fill the capacity completely. Both "forbiddance" and "allowance" policy are optimal.

#### Theorem 4

When “allowance” policy is the norm and  $M \geq C$  and  $N \geq C$ , both “allowance” and “forbiddance” policies are optimal and the optimal price is  $P = S$ .

Proof:

The proof of Theorem 4 is similar to the proofs in Section 3.

According to Theorem 4, targeting on each group of customers could reach the optimality when each group alone can completely fill the capacity.

#### 4.2 Scenario 2 : $M \geq C, N < C, M + N \geq C$

In scenario 2, A-group customers alone can completely fill the capacity. The optimal policy is “forbiddance” and the optimal price is  $P = S$ .

Theorem 5

When “allowance” policy is the norm and  $M \geq C$  and  $N < C$ , the optimal policy is “forbiddance” and the optimal price is  $P = S$ .

The proof of Theorem 5 is similar to the proofs in Section 3.

Further, the implication of Theorem 5 is discussed. When A-group customers alone can completely fill the capacity, it’s optimal to adopt “forbiddance” policy and set the price  $P = S$ . That is, focusing on A-group customers could generate the maximal revenues.

#### 4.3 Scenario 3 : $M < C, N \geq C, M + N \geq C$

In scenario 3, B-group customers alone can completely fill the capacity. The optimal policy is “allowance” and the optimal price is  $P = S$ . The argument is proved in Theorem 6.

Theorem 6

When “allowance” policy is the norm and  $M < C$  and  $N \geq C$ , the optimal policy is “allowance” and the optimal price is  $P = S$ .

The proof of Theorem 6 is similar to the proofs in Section 3.

According to Theorem 6, it’s optimal to set policy as “allowance” and set price as  $P = S$  to focus on B-group customers when only B-group customers can completely fill the capacity.

#### 4.4 Scenario 4 : $M < C, N < C, M + N \geq C$

In scenario 4, each group of customers can only fill part of the capacity. Both groups of customer can completely fill the capacity. Now, the policy and pricing decisions and their corresponding revenues are as Table 6.

**Table 6 : The policy and pricing decisions and their corresponding revenues in scenario 4 in Section 4**

Decision Combination			
Number	Policy	Pricing	Revenues
1	Allowance	$P = S$	$N * S$
2	Allowance	$P = S - N * N_n$	$C * (S - N * N_n)$

3	Forbiddance	$P = S$	$M * S$
4	Forbiddance	$P = (S - E)$	$C * (S - E)$

The optimal policy and pricing decision combination is the one leading to the maximal revenues.

#### 4.5 Scenario 5 : $M < C, N < C, M + N < C$

In scenario 5, each group of customers can only fill part of the capacity. Even both groups of customers cannot completely fill the capacity. Now, the policy and pricing decisions and their corresponding revenues are as Table 7.

**Table 7 : The policy and pricing decisions and their corresponding revenues in scenario 5 in Section 4**

Decision Combination			
Number	Policy	Pricing	Revenues
1	Allowance	$P = S$	$N * S$
2	Allowance	$P = S - N * N_n$	$(M + N) * (S - N * N_n)$
3	Forbiddance	$P = S$	$M * S$
4	Forbiddance	$P = (S - E)$	$(M + N) * (S - E)$

The optimal policy and pricing decision combination is the one leading to the maximal revenues.

Theorem 7.1

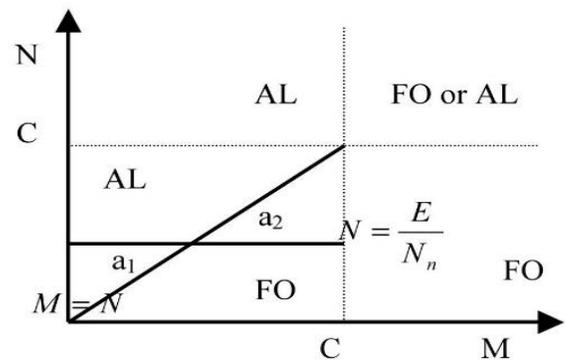
Under the setting allowance is the norm and  $M < C$  and  $N < C$ . When  $N > M$  and  $N < \frac{E}{N_n}$ , the optimal policy is “allowance”.

Theorem 7.2

Under the setting allowance is the norm and  $M < C$  and  $N < C$ . When  $N < M$  and  $N > \frac{E}{N_n}$ , the optimal policy is “forbiddance”.

The proofs of Theorems 7.1 and 7.2 are similar to the proofs in Section 3.

The analytical result of Theorem 4~7.2 are combined to form Figure 3.



**Figure 3 : The optimal policy when “allowance” policy is the norm**

It's interesting that intuition applies well in most cases except the two areas:  $a_1$  and  $a_2$  in Figure 3; e.g. in area  $a_1$ , "forbiddance" policy is optimal when  $(M+N)*(S-E) > N*S$ . The case is contradictory to intuition.

When "allowance" policy is the norm, the intuition (see Figure 1) applies well in most cases. However, the possibility of misjudgment of policy and pricing decision still exists when  $M < C$  and  $N < C$ .

### 5. "Forbiddance" Policy is Partially Expected (Generalization of 3. and 4.)

Some customers may seek others' personal data in their interest. In online games, online auctions, and online chat rooms, some service providers forbid the behavior and others allow that. Thus, customers take neither "forbiddance" nor "allowance" policy as granted. This reality in practice is called "partially expected" in this paper.

B-group customers facing "allowance" policy would feel better to be allowed to do the behavior they love. In the model, B-group customers' utility would raise (denoted by  $e_1$ ) when B-group customers face "allowance" policy.

On the other hand, B-group customers facing "forbiddance" policy would feel somehow disappointed to be forbidden to do the behavior they love. In the model, B-group customers' utility would drop (denoted by  $e_2$ ) when B-group customers face "forbiddance" policy.

The value of  $e_1+e_2$  is assumed to be equal to  $E$  for the same utility due to the same behavior.

Section 3 is a special case of Section 5 by setting  $e_1 = E$  and  $e_2 = 0$ . Also, the Section 4 is another special case of Section 5 by setting  $e_1 = 0$  and  $e_2 = E$ . Thus, Section 5 is the generalization of Section 3 and 4. Those are shown in Table 8.

**Table 8 : The utility settings in Section 5.**

Utility Group	Policy	"Forbiddance" policy	"Allowance" policy	
			With B-group customers	Without B-group customers
A		S	$S - N*N_n$	S
B		$S - e_2$	$S + e_1$	

Five scenarios, which regard the relative sizes of  $M$  and  $N$  and  $C$ , are analyzed to find the optimal policy and pricing decision. Table 9 could illustrate the settings of five scenarios.

**Table 9 : The parameter settings in Section 5**

Scenario 1	$M \geq C, N \geq C, \text{ and } M + N \geq C$
Scenario 2	$M \geq C, N < C, \text{ and } M + N \geq C$
Scenario 3	$M < C, N \geq C, \text{ and } M + N \geq C$
Scenario 4	$M < C, N < C, \text{ and } M + N \geq C$
Scenario 5	$M < C, N < C, \text{ and } M + N < C$

#### 5.1 Scenario 1 : $M \geq C, N \geq C, M + N \geq C$

In scenario 1, each group of customers alone can completely fill the capacity. It's optimal to adopt "allowance" policy to attract B-group customers and set price at  $P = S + e_1$ .

#### Theorem 8

When "forbiddance" is partially expected and  $M \geq C$  and  $N \geq C$ , the optimal policy is "allowance" and the optimal price is  $P = S + e_1$ .

The proof of Theorem 8 is similar to the proofs in Section 3.

Further, the implication of Theorem 8 is discussed. Although meeting preference of either group of customers could completely fill the capacity, it's optimal to meet B-group customers' preference for their high utility perceived ( $S + e_1 > S$ ).

#### 5.2 Scenario 2 : $M \geq C, N < C, M + N \geq C$

In scenario 2, A-group customers alone can completely fill the capacity.

##### Theorem 9.1

Under the setting "forbiddance" is partially expected and  $M \geq C$  and  $N < C$ . When  $N > \frac{CS}{S + e_1}$ , the optimal policy is "allowance" and the optimal price is  $P = S + e_1$ .

##### Theorem 9.2

Under the setting "forbiddance" is partially expected and  $M \geq C$  and  $N < C$ . When  $N < \frac{CS}{S + e_1}$ , the optimal policy is "forbiddance" and the optimal price is  $P = S$ .

The proofs of Theorems 9.1 and 9.2 are similar to the proofs in Section 3.

Theorems 9.1 and 9.2 could be applied in situations that market is divided into a high-end segment with fewer customers and a low-end segment with more customers. In such situations, only attracting one group of the two groups of customers is optimal by serving the high-end segment and charging them a higher price or serving the low-end segment and charging them a lower price. It's worthy to pay attention that the model applies most when the high-end customers would do some annoying behavior to reduce low-end customers' utility.

#### 5.3 Scenario 3 : $M < C, N \geq C, M + N \geq C$

In scenario 3, B-group customers alone can completely fill the capacity.

##### Theorem 10

When "forbiddance" is partially expected and  $M < C$  and  $N \geq C$ , the optimal policy is "allowance" and the optimal price is  $P = S + e_1$ .

The proof of Theorem 10 is similar to the proofs in Section 3.

#### 5.4 Scenario 4 : $M < C, N < C, M + N \geq C$

In scenario 4, each group of customers alone can only fill part of the capacity. Both groups of customers can completely fill the capacity. Now, the policy and pricing decisions and their corresponding revenues are as Table 10.

**Table 10 : The policy and pricing decisions and their corresponding revenues in scenario 4 in Section 5**

Decision Combination			
Number	Policy	Pricing	Revenues
1	Allowance	$P = S + e_1$	$N^*(S + e_1)$
2	Allowance	$P = S - N^*N_n$	$C^*(S - N^*N_n)$
3	Forbiddance	$P = S$	$M^*S$
4	Forbiddance	$P = S - e_2$	$C^*(S - e_2)$

The optimal policy and pricing decision combination is the one leading to the maximal revenues.

### 5.5 Scenario 5 : $M < C, N < C, M + N < C$

In scenario 5, each group of customers alone can only fill part of the capacity. Even both groups of customers cannot completely fill the capacity. Now, the policy and pricing decisions and their corresponding revenues are as Table 11.

**Table 11 : The policy and pricing decisions and their corresponding revenues in scenario 5 in Section 5**

Decision Combination			
Number	Policy	Pricing	Revenues
1	Allowance	$P = S + e_1$	$N^*(S + e_1)$
2	Allowance	$P = S - N^*N_n$	$(M + N)^*(S - N^*N_n)$
3	Forbiddance	$P = S$	$M^*S$
4	Forbiddance	$P = S - e_2$	$(M + N)^*(S - e_2)$

The optimal policy and pricing decision combination is the one leading to the maximal revenues.

#### Theorem 11.1

Under the setting forbiddance is partially expected and  $M < C$  and  $N < C$ . When  $N > \frac{MS}{S + e_1}$  and

$$N < \frac{e_2}{N_n}, \text{ the optimal policy is "allowance".}$$

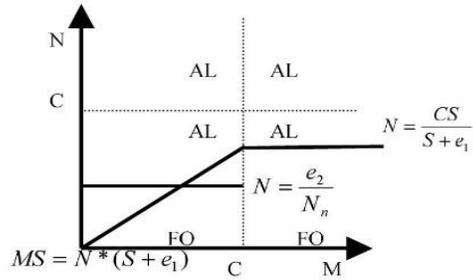
#### Theorem 11.2

Under the setting forbiddance is partially expected and  $M < C$  and  $N < C$ . When  $N < \frac{MS}{S + e_1}$  and

$$N > \frac{e_2}{N_n}, \text{ the optimal policy is "forbiddance".}$$

The proofs of Theorems 11.1 and 11.2 are similar to the proofs in Section 3.

The analytical result of Theorem 8~11.2 are combined to form Figure 4.



**Figure 4 : The optimal policy when forbiddance policy is partially expected**

It's surprising that the policy and pricing decision made by intuition (Figure 1) could deviate from optimality when  $M > C$  and  $N < C$ . Besides, "allowance" policy could be optimal even when the externality-hating segment (denoted by M) is larger than the externality-loving segment (denoted by N) and the capacity (denoted by C).

## 6. Conclusion

When customers in reality are of two distinct groups with opposite preferences, following the intuition (Figure 1) to accommodate the majority may not guide the decision toward optimality. By comparing Figure 1 with Figure 2, 3,4 we know that intuition applies well only in limited situations.

This paper improves policy and pricing decisions and presents three decision support figures (Figure 2, 3, 4). It's convenient to judge the optimal policy (to allow or to forbid) and corresponding optimal price with the three figures when parameters' values are known.

The results contradict to some intuitions. First, intuition may tell us that negative externality is harmful to customers' utility and service provider's revenues. Thus, it is favorable to eliminate the externality. In this paper, "forbiddance" policy that eliminates the annoying behavior is not always optimal. When the externality-loving segment is large enough, it's optimal to adopt "allowance" policy to delight this segment.

Second, intuition may tell us meeting the preference of the majority of customers brings the most revenues. In this paper, the intuition may guide to the wrong way especially when "forbiddance" policy is the norm.

This paper conforms to recent empirical researches and also manifests its uniqueness. [12] pointed out that externality caused by customers' behavior is related with situation context ("allowance" policy or "forbiddance" policy). The paper is a trial to incorporate Martin's opinion into model analysis. This paper bases on "customer-centric" concept [15] to analyze the influence of service policy on customers' utility. The presented model includes conflicting attributes (opposite preferences) as [3] and addresses the importance to understand customers' characteristics and needs as [6].

There are some future research possibilities. First, the model can be extended to the two online interactive service providers' case and the game theory would apply to offer more insights of the issue in competitions.

Second, the assumption that A-group customers all know the choice behavior of B-group customers can be relaxed to see the effects of imperfect information.

#### Appendix

Appendix is available from the authors if readers are interested.

#### Reference

- [1] Bensaid, B. & Lesne, J.-P. "Dynamic monopoly pricing with network externalities," *Intern. J. of Ind. Organ.*, 1996,14(6),837-855.
- [2] Cabral, L.M.B. & Salant, D.J. & Woroch, G.A. "Monopoly pricing with network externalities," *Intern. J. of Ind. Organ.*, 1999,17(2),199-214.
- [3] Chen, C. "Designing for the environment: A quality-based model for green product development," *Management Sci.*, 2001,47(2),250-263.
- [4] Chiang, D.M. & Teng, D.C. "Network externalities between two groups of customers," *NTU Management Rev.*, 2001,12(1),1-36.
- [5] Farrell, J. & Saloner, G. "Standardization, compatibility, and innovation," *Rand.J. of Econ.*, 1985,16(1),70-83.
- [6] Freytag, P.V. & Clarke, A.H. "Business to business market segmentation," *Ind. Marketing Management*, 2001,30(6), 473-486.
- [7] Johnson, M.D. "Modeling choice strategies for noncomparable alternatives," *Marketing Sci.*, 1986,5(1), 37-54.
- [8] Katz, E. & Spiegel, U. "Negative intergroup externalities and market demand," *Economica*, 1996,63(251),513-520.
- [9] Katz, M.L. & Shapiro, C. "Network externalities, competition, and compatibility," *Am. Econ. Rev.*, 1985,75,424-440.
- [10] Kotler P. & Leong, S.M. & Ang, S.H. & Tan, C.T. *Marketing management: An asian perspective*. Prentice Hall. 1996.
- [11] Kurtz, D.L. & Clow, KE. *Service marketing*. John Wiley & Sons. 1998.
- [12] Martin, C.L. "Consumer-to-consumer relationships: Satisfaction with other consumers' public behavior," *J. of Consumer Affairs*, 1996,30(1),146-169.
- [13] McFadden, D. "Choice theory approach to market research," *Marketing Sci.*, 1986,5(4),275-297.
- [14] Riggins, F.J. & Kriebel, C.H. & Mukhopadhyay, T. "The growth of interorganizational systems in the presence of network externalities," *Management Sci.*, 1994,40(8),984-998.
- [15] Sheth, J.N. & Sidodia, R.S. & Sharma, A. "The antecedents and consequences of customer-centric marketing," *J. of the Academy of Marketing Sci.*, 2000,28(1),55-66.
- [16] Westland, J.C. "Congestion and network externalities in the short run pricing of information system online interactive services," *Management Sci.*, 1992,38(7),992-1009.
- [17] Zeithaml, V.A. & Berry, L.L. & Parasuraman, A. "The nature and determinants of customer expectations of online interactive services," *J. of the Academy of Marketing Sci.*, 1993,21,1-12.

# Use of Graphic Images and Text Characters in Internet Banners as an Effective Marketing Tool

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## Abstract

Participants were presented with a list of Internet banners and asked to perform a series of matching tasks to test the effectiveness of using graphic images as compared with verbal characters in web-site banners for e-marketing purposes. Participants studied ten different web pages. The web banners consisted of image or characters that had some degree of linkage to the corresponding web contents. Results show that: (a) participants have a greater ability to match web contents if banners are relevant to the web page contents; (b) contextual cues can be enriched by the context of the images used in the web banners; (c) frequent web surfers are less likely to recall web banners than normal web users. These findings are discussed in light of research on the effect of “picture superiority” and “semantic coding” on memory of pictures and words. This study concluded that the selection of graphic elements in web banners is important to an effective e-marketing strategy.

## 1. Introduction

The Internet has provided many opportunities for marketers, and a countless number of different online advertisements can be found on web sites. Companies have experimented with the use of various graphic-oriented web components, such as banners and animated images, to capture the attention of busy web visitors. Previous research efforts have focused primarily on the importance of the Internet as a marketing tool. Only a few studies have been undertaken to identify the effectiveness of different graphic-oriented web components— that is, the graphics and characters used in advertisements. This study therefore attempts to address the importance of memory for pictures, as developed in earlier research, and examines how tracking online consumer behavior allows companies to design their web pages such that can they capture the attention of web users in more effective ways.

## 2. Cues from pictures and characters

Studies have found that people can recall pictures much better than words [1][5][7]. The most influential contribution to the discussion about the effectiveness of people’s pictorial memory was presented by Bower, Karlin, & Dueck (1975) [1]. They found that participants recalled pictures better if they achieved a meaningful interpretation of the picture used in the experiment. In their first experiment, a group of 18 undergraduates was divided into two groups— designated ‘label’ and ‘no-label’ groups. All participants were asked to study a series of 28 simple doodled pictures. Appropriate interpretation was given by the experimenter to the ‘label’ group, whereas no interpretation was given to the ‘no-label’ group. The results of the experiment indicated that the ‘label’ group did better in recalling the pictures than the ‘no-label’ group. In the second experiment, Bower, Karlin, & Dueck (1975) [1] tried to test the participants’ ability for associative matching. Doodle pairs were shown to the participants once, and the experimenter then asked the participants to match the corresponding pairs. Again, the ‘label’ group did better than the ‘no-label’ group in the matching exercise.

Similarly, Rafnel & Klatzky (1978) [6] found that semantic encoding of a picture can be facilitated by a meaningful label. Three separate experiments were conducted to test the effect of meaningful interpretation on participants’ memory for nonsense pictures. In each test, the participants’ retention was assessed by a recognition test with certain distractors. It was found that the physical appearance of the pictures shown to participants did not help them in recalling meaningless pictures. However, the experimenters found that participants did recall meaningful pictures better. The findings indicated that the semantic interpretation of a picture enhances semantic coding, rather than the physical coding.

From the more recent experiments conducted by Dewhurst & Conway (1994) [2], it was suggested that encoding conditions in sensory-perceptual and semantic

processing affect recall ability. Five experiments were conducted to investigate whether pictures can provide rich information for sensory-perceptual coding, rather than the conceptual representation of texts. Findings were consistent with the previous studies— that is, that picture superiority effect was found in meaningful pictures as compared with nonsense pictures.

Several factors affect picture superiority. From the sensory-semantic model proposed by Nelson, Reed, & McEvoy (1977) [4], picture superiority takes place only in certain conditions. These conditions are: (a) pictures that pose more distinctive sensory codes than words; and (b) pictures that are more likely to undergo semantic processing than verbal labels. As noted by Durso & Johnson (1980) [3], some studies in the past have failed to yield a picture superiority effect because of a lack of meaningful representation. Therefore, it would seem that people try to assign meaning to what they have seen in order to facilitate recall.

Durso & Johnson (1980) [3] have conducted two experiments to test the validity of the model of Nelson, Reed, & McEvoy (1977) [4]. The first experiment tried to identify the effect of different orienting tasks on the subsequent recognition of concepts presented in either graphic or verbal form. Participants were presented with a list of pictures and words, and were then required to perform certain tasks which tested for an association between the pictures and words, with or without defined concepts. The findings were compatible with the sensory-semantic model, in which the sensory distinctiveness of pictures and the ability to perform semantic processing were enhanced by pictures with a greater picture superiority effect.

### 3. Research objectives

The research presented in this paper investigated the ability to recall graphic and verbal elements used in web pages. Two general research questions emerged from the literature review of the previous section. These were:

1. Does the picture superiority effect extend to Internet web pages?
2. Do the participant's characteristics (such as the level of web usage and gender) affect the assertiveness of graphic elements used in web pages?

Regarding the first question, it was hypothesized that meaningful graphic contexts used in web pages can capture a participant's attention on a given web page better than can verbal elements. For the second research question, it was hypothesized that a participant's characteristics (such as the level of web usage, age, and gender) do not influence the memory structures (that is, the schemata) that are accessed during the initial perception and encoding of a message received from a shown web page.

## 4. Method

### 4.1 Participants

Participants were 136 part-time MBA students from two universities in Hong Kong. They included 58 participants studying the interactive MBA program, in which much of the course materials are provided on the world wide web. All participants were volunteers for this study. They were assumed to have a similar cultural pattern, but different individual levels of usage of the Internet. However, all were asked to undertake a short Internet 'basic knowledge' test. This established that all participants were fully capable of using the Internet. The mean age of participants was 36.11. A total of 136 participants (89 male, 47 female) were tested.

### 4.2 Stimulus materials

The stimuli consisted of thirty web banners downloaded from various local and international web sites (for example, amazon.com; 30.com; ebay.com; and so on). The major business conducted by these web sites included online shopping, electronic banking, online auction, online newspapers, and search engines. Based on the web banner used in the web sites, they were divided into three categories of stimuli— (i) a purely verbal banner; (ii) a nonsense graphic banner; and (iii) a graphic banner with direct linkage to the particular web site's contents.

### 4.3 Procedure

The study was based on the research designs developed by Bower, Karlin, & Dueck (1975) [1], with some modification for the application of the two research questions noted above. All participants were given a brief introduction regarding the objectives of this study. The experimenter then presented a set of web pages with corresponding web banners. Participants had 30 seconds to look at each web page. After looking at the web pages, all participants continued their regular lesson. In the next class— that is, a week after the initial stage of the experiment— they were asked to recall each of the web banners presented to them, and were asked to match the recalled pages with the corresponding web contents by a paper-and-pencil matching exercise. Additional web banners were included in the matching exercise— that is, web banners and web pages that had not been previously presented to the participants. On the first page of the matching exercise was a statement instructing participants on how to complete the matching exercise. They were given 15 minutes to complete the matching. No discussion among participants was allowed.

## 5. Results

The simple student's *t*-statistic (*t*-test) was used to compare the differences in the mean scores for the two research questions. Results for the first research question were dramatic. Table 1 shows that participants were far less likely to recall and match nonsense graphic web banners with the corresponding web pages than meaningful graphic web banners and verbal web banners. On average, each participant correctly matched 4.56 pieces of nonsense graphic web banners, compared with 9.10 pieces of meaningful graphic web banners ( $t = 49.89$ ; d.f. = 135,  $p < 0.001$ ) and 8.01 pieces of verbal web banners ( $t = 35.26$ ; d.f. = 135,  $p < 0.001$ ). Table 1 shows that participants did better in the matching exercise for meaningful graphic web banner than for verbal web banners ( $t = 15.30$ , d.f. = 135,  $p < 0.001$ ).

**Table 1. Means and standard deviations of the scores in the matching exercise for different kinds of web banner**

Category of web banner	N	Mean score	S.D.
Meaningful graphic web banner	136	9.10	1.21
Nonsense graphic web banner	136	4.57	1.30
Verbal web banner	136	8.01	1.26

Not surprisingly, gender did not affect the power of picture superiority. The results showed an insignificant difference between males and females in the matching exercise for meaningful graphic web banners ( $t = -0.172$ ; d.f. 134,  $p > 0.05$ ). Similar results were found for the nonsense graphic banners and the verbal graphic banners (Table 2).

**Table 2. Means and standard deviations of the scores in the matching exercise for different gender group**

Category of web banner	Male			Female		
	N	Mean score	S.D.	N	Mean score	S.D.
Meaningful graphic web banner	89	9.09	1.28	47	9.13	1.10
Nonsense graphic web banner	89	4.65	1.30	47	4.40	1.30
Verbal web banner	89	7.94	1.25	47	8.15	1.30

Note: Means in the same row do not share mean differ at  $p < 0.05$ .

However, the level of web usage did affect recall. It was found that frequent web surfers were most likely to have forgotten what they had seen than were normal web users (Table 3). It was found that frequent web surfers recalled 8.61 pieces of meaningful graphic web banners in the matching exercise, whereas normal users recalled 9.54 pieces of a total of 12 pieces of meaningful graphic web banners ( $t = -4.83$ ; d.f. 134,  $p < 0.001$ ). Similar findings were found for nonsense graphic web banners and verbal web banners (Table 3).

**Table 3. Means and standard deviations of the scores in the matching exercise for different group of web surfers**

Category of web banner	Frequent web surfers			Normal web users		
	N	Mean score	S.D.	N	Mean score	S.D.
Meaningful graphic web banner	64	8.61	1.11	72	9.54	1.14
Nonsense graphic web banner	64	4.11	1.29	72	4.97	1.17
Verbal web banner	64	7.38	1.16	72	8.58	1.07

Note: Means in the same row show mean difference at  $p < 0.001$ .

## 6. Discussion

Two questions guided this study. The first was whether the picture superiority suggested by Bower, Karlin, & Dueck (1975) [1] also applied to web elements. The answer seems to be that it does. The present findings demonstrate that memory of the materials seen by participants depends upon the construction of meaningful interpretations of the web banners as they are viewed. Results from the matching exercise demonstrated that semantic interpretation is a major determinant of how well a person can remember a web banner. Consistent with previous studies for picture superiority, people having meaningful illustrations for the web elements reported a greater successful recall rate.

Secondly, the study asked whether the participant's characteristics (that is, the level of web usage and gender) affect recall of the graphic web elements used. The answer seems to be variable. Frequent web surfers did poorly in the matching exercise for both kinds of web banners they had previously seen. However, the gender variable did not interact with recall on any kinds of the web banner. The latter finding was not in accordance with the body of research which has repeatedly demonstrated differences in recall for female and male.

The online population is growing, and it is clear that the Internet is a multi-segment market channel. It is an increasingly important channel for the deployment of marketing strategies. An effective web element in such strategies is one that creates an attractive presence to its targeted segment. Creating an effective web presence can be critical for firms operating on the web. The findings of this study suggest that e-marketers should take more care in the design of their web pages. People are not pleased with web pages that are purely word-based. As technology develops, more computer animations are

likely to be put on the web. These distinctive web elements should be closely related to the nature and contents of the corresponding web page. This is especially so for web pages that target frequent web surfers. More interactive web elements should be used to capture this market.

## 7. References

- [1] Bower, G. H., Karlin, M. B., & Dueck, A. (1975). Comprehension and memory for pictures. Memory & Cognition, 3(2), 216–220.
- [2] Dewhurst, S. A., & Conway, M. A. (1994). Picture, images and recollective experience. Journal of Experimental Psychology: Learning Memory and Cognition, 20(5), 1088–1098.
- [3] Durso, F. T., & Johnson, M. K. (1980). The effects of orienting tasks on recognition, recall, and modality confusion of pictures and words. Journal of Verbal Learning and Verbal Behavior, 19(4), 416–429.
- [4] Nelson, D. L., Reed, V. S., & McEvoy, C. L. (1977). Learning to order pictures and words: A model of sensory and semantic encoding. Journal of Experimental Psychology: Human Learning and Memory, 3(5), 485–497.
- [5] Paivio, A., Rogers, T. B., & Smythe, P. C. (1968). Why are pictures easier to recall than words? Psychonomic Science, 11(4), pp. 137–138.
- [6] Rafnel, K. J., & Klatzky, R. L. (1978). Meaningful-Interpretation effects on codes of nonsense pictures. Journal of Experimental Psychology: Human Learning and Memory, 4(6), 631–646.
- [7] Shepard, R. N. (1967). Recognition memory for words, sentences, and pictures. Journal of Verbal Learning and Verbal Behavior, 6(1), 156–163.

# Why People Forward Emails to Others?

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## Abstract

The issue of electronic mail (e-mail) communication has attracted much academic attention over the last two decades. Yet, little is known about why people forward emails to others. Through a review of the literature, this paper aims to investigate reasons why people forward emails and proposes several variables related to one's intention of doing so. More specifically, we hypothesize that the higher degree the four possible variables are (the recipient's trust in the email content, the recipient's trust in the senders, intention to staying in touch with friends, and the receivers' altruism trait), the more likely people will forward emails. On the other hand, we hypothesize that the lower degree the two possible variables are (the size of email file, and the cost of forwarding e-mail), the less likely people will forward emails.

Keywords: email communications, trust, trait, Internet marketing

## 1. Introduction

Nowadays, more and more people are using e-mail for their daily communications. According to a recent Nielsen/NetRatings report of 12 countries over the past five months, more than 531 million people are using Internet worldwide and email ranked first among the all the Internet usage. Furthermore, a Net Value survey showed that, the popularity rate of email usage is 69.1% for Taiwanese netusers, ranked first among the four little dragons in Asia, Hong Kong, South Korea and Singapore. In addition to a MCI report, email communication ranked first among all the purposes of Taiwanese's using Internet [8]. This can be attributed to e-mail's characteristics, such as simplicity, low cost, fast, convenience and so on [8] [12][14]. However, while people receive numerous emails each day, many of which are unsolicited and quickly deleted [8]. Still, many others are kept in personal files or forwarded to family, friends, colleagues, etc.

Over the past two decades, the issue of email communication has received much of researcher's attention [9][10][13]. However, not much has been done regarding e-mail forwarding behavior intention. As a result, we know very little about why people forward emails to others. Therefore, the purposes of this paper are to review literature and propose several variables influenced the intention of one's forwarding emails to others.

## 2. Literature review

Email is a way of communication between people or organizations via Internet system. Files or letters can be transferred between the two parties through email, on condition that each one has its own email box [9]. In other words, email enables people to communicate, to exchange data, and to increase interactions [2].

Previous research of email has been focused on issues like usage rate and purposes [9][10][13]. In recent years the track has shifted to attitude towards email usage [2]. Also, marketing impact of email has attracted much attention these days.

More and more messages are transferred through emails, as a result, it has become an important issue to investigate the reasons why people forward emails. This topic is crucial from a theory perspective as it can be of help in constructing a model for better understanding email usage behavior. From a practical viewpoint, it can assist marketers in developing advertising strategies in the web world.

Forwarding e-mail is a popular way of communication these days. According to communication theory, its effectiveness is affected by source credibility, message content and personal trait of the user [4]. This research is based on source credibility, message content and user's trait, three factors that have much influence on communication effects, and to try to explore the reason why people forward emails in more detail.

Therefore, the research will then base on the above literature reviewed to develop the following hypotheses.

## 3. Research Hypotheses

Extending current research, we present the following people perceptions of source credibility, the content of email, and the user's trait as major determinants of the intention to forward email to others.

### 3.1 The recipient's trust in the email content

Past research showed that message credibility is one of the factors influencing communication effect. That is, people are more inclined to forward a message if the message is considered to be reliable, regardless of the attribute of it [4]. In essence, forwarding email is a way of communication. The research, hence, hypothesize that the higher the content credibility the more likely that one will forward an email.

*Hypothesis 1:* the more the trust of the recipients in the email content, the higher the intention of forwarding emails to others;

### **3.2 Source credibility**

Another factor believed to have impact on communication effect is source credibility. That is, one is more inclined to forward an email received from a trustworthy person [4]. Reviewing of other related literature indicated that there are three dimensions affecting the reliability of source credibility: the source being having related knowledge and experience, the feeling of sincerity of the source, and the charisma of the source itself [11]. The arguments with personal experience or viewpoints from authoritative people tend to be more reliable and convincing [11]. The research, hence, hypothesize that the higher the source credibility the more likely that one will forward an email. That is, one is more inclined to forward an email received from a trustworthy person.

*Hypothesis 2:* the more the trust of the recipients in the senders, the higher the intention of forwarding emails to others;

### **3.3 The receivers' altruism trait**

A review of the literature related to communication revealed that personal trait plays an important role in message transmission [4] and the way one communicates with others [6]. For instance, one who fears of speaking in public will choose a way of communication not having to face much audience. Some researchers, therefore, argued that one's communication style could be predicted by his personal trait [6].

That is, the receivers have more altruism trait, the higher the intention of forwarding emails to others. Thus, the following hypothesis was proposed:

*Hypothesis 3:* the more the altruism the recipients have, the higher the intention of forwarding emails to others; and

### **3.4 Staying in touch with friends**

According to social exchange theory [1], the interaction between people is in fact a mutually beneficial kind of behavior. People will engage in message exchange for rational reasons as well as for gaining some rewards. Apart from receiving some forms of external rewards, one may also get some internal benefits from message exchange, such as friendship, love and social interdependence. One can sustain his social relationship through forwarding of emails. From the angle of social exchange theory, the convenience and speed of email enable it to become a most effective way of increasing interaction and social relationship between people [5]. Evidence from some empirical research [15] showed that the main purposes for 61% of the respondents using emails at home are to keep contact with friends and relatives. Furthermore, another research found that people tend to forward emails as a way of staying in

touch with their friends [2]. Furthermore, interpersonal relationships can be built through email as well as they are in face to face to interactions [17]. The research, therefore, propose that the higher one intends to maintain a stable relationship with others the more likely that one will forward emails.

*Hypothesis 4:* the more intention to staying in touch with friends, the higher intention in forwarding emails to others.

### **3.5 The size of email file**

The size of an email file will affect the speed required to transfer it. The larger the file is the longer it will take to transfer it. Hence, we proposed that the smaller the file the more likely that one will forward it to others.

*Hypothesis 5:* the less size of e-mail file, the higher intention in forwarding emails to others.

### **3.6 The cost of forwarding e-mail**

Most human behavior has its root in increasing one's benefits and decreasing costs at the same time [3] [16]. Researchers of social exchange theory assumed that it is human nature to pursue benefits [1]. Hence, people will rationally assess the costs and benefits of message exchange. That is, the less cost for forwarding and emails the more likely that people will do it.

*Hypothesis 6:* the lower cost of forwarding e-mail, the higher intention in forwarding emails to others.

## **4. Conclusion and suggestions for future research**

The final section draws conclusions and makes suggestions for future research on forwarding e-mail should address.

### **4.1 Conclusion**

We hypothesize that the higher degree the four possible variables are (the recipient's trust in the email content, the recipient's trust in the senders, intention to staying in touch with friends, and the receivers' altruism trait), the more likely people will forward emails. On the other hand, we hypothesize that the lower degree the two possible variables are (the size of email file, and the cost of forwarding e-mail), the less likely people will forward emails.

### **4.2 Suggestions for future research**

It is suggested that further research can adopt qualitative or quantitative approach to empirically test the six hypotheses proposed in this research so as to get a deeper understanding of the reasons why people forward emails to others.

In quantitative approach, a questionnaire will be developed to identify frequent email users and forwarders, and the reasons why people forward emails. In

qualitative approach, face-to-face interviews will be undertaken to ask frequent email users the reasons why they forward emails.

In sum, this study is proposed to get the hypotheses that the several variables investigated, the content of emails, the trust of the recipient's in the senders, the receivers' altruism trait, and the recipient's intention of keeping in touch with others will all positively related to the intention of forwarding emails to others.

## Reference

- [1] Emerson, R. M. "Social Exchange Theory" in Alex Inkeles and Neil J. Smelser (eds), *Annual Review of Sociology*, 2, Palo Alto, California: Annual Reviews Inc., 1976, 335-359.
- [2] Hacker, K. L., Townley, C. & Horton, V. J. "Employee attitudes regarding electronic mail policies: a case study," *Management Communication Quarterly*, 1998, 11(3), 422-452.
- [3] Homans, G. C. *Social behavior: Its elementary forms*, New York: Harcourt Brace and World, 1961.
- [4] Hovland, C. I., Janis, I. L., & Kelley, H. H. *Communication and Persuasion: psychological studies of opinion change*, New Haven, Conn.: Yale University Press, 1953.
- [5] Kraut, R. & Mukhop, Adhyay T. "Information and Communication: Alternative Uses of the Internet in Households," *Information Systems Research*, 1999, 10(4), 287-304.
- [6] Littlejohn S. W. *Theories of Human Communication*, Wadsworth, 1992.
- [7] Market Intelligent Center, MIC The Internet use and Development In 2001 Yearbook, Taipei: Department of Industrial Technology, 2001.
- [8] McManus, D. J. Sankar, C. S. Carr, H. H. & Ford, F. N. "Intraorganizational versus interorganizational uses and benefits of electronic mail," *Information Resources Management Journal*, 2002, 15(3), 1-13.
- [9] Rice, R. E. & Case, D. "Electronic message systems in the university: A description of use and utility," *Journal of Communication*, 1983, 33(1), 131-152.
- [10] Rice, R. E. & Shook, D. E. "Relationships of job categories and organization levels to use of communication channels," *Journal of Management Studies*, 1990, 27(2), 195-229.
- [11] Rosen, E. *The Anatomy of Buzz: Creating Word-of-Mouth Marketing*, 2000, PerfectBound.
- [12] Rudy, I. A. "A critical review of research on electronic mail," *European Journal of Information Systems*, 1996, 4(4), 198-213.
- [13] Soe, L. L. & Markus, M. L. "Technologies and social utility? Unraveling explanations of e-mail, vmail, and fax use," *The Information Society*, 1993, 9(3), 213-236.
- [14] Sproull, L. S. "Using electronic mail for data collection in organizational research," *Academy of Management Journal*, 1986, 29(1), 159-169.
- [15] Stafford, L., Kline, S. L., & Dimmick, J. "Home email: Relational maintenance and gratification opportunities," *Journal of Broadcasting and Electronic Media*, 1999.
- [16] Thibaut, J. W. & Kelly H. *The social psychology of groups*, New York: Wiley, 1959.
- [17] Walther, J. B. & Burgoon, J. K. "Relational communication in computer-mediated communication," *Human Communication Research*, 1992, 19, 50-88.

# Motivation and Consumer Knowledge on Processing Online Advertisement

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## Abstract

This study investigated how consumers use their motivation and objective knowledge to process online advertisement. The laboratory experiment tested several hypotheses on the determinants of consumers' process measures toward the ad. The findings suggested that involved subjects tended to process the ad more to a certain point until subjects reached the highest involvement level and did not feel the need to processing the ad anymore. In addition, when objective knowledge remained an accessible source to evaluate the ad, it hindered the persuasion effects of the ad. Implications for advertisers and the direction of future research are also presented.

## 1. Introduction

The increasing number of people accessing the Internet is fueling the increase of online sales. "Even though this amount could change due to the economic slowdown, eCommerce still won't shrink. Conversely, if the current economic storm passes early, eCommerce will experience substantial growth in 2002" (URL: <http://www.forrester.com/ER/Press/Release/0,1769,651,00.html>) [12]. New communication technologies are creating new challenges for the advertising industry. While the Internet represents new possibilities for advertisers, there is little information available regarding how to take advantage of the Internet.

The Internet makes it possible to create ads or information that are more targeted, accessible, and more personal. Thus, seeing an online banner ad can be an experience in which the consumer participates and is engaged. How engaged they are may depend on how motivated and knowledgeable they are. While separating the effects of involvement and domain knowledge "remains problematic because they are related" [6, p.213], several studies and untested propositions do suggest they can independently influence information processing [30; 1; 16; 4]. This is especially true when knowledge is usually distinguished among three types: objective knowledge, subjective (self-assessed) knowledge, and product-related experience (familiarity). By studying these factors, this study can answer or test how these factors independently influence consumer's information processing toward online advertisement. Moreover, the results might suggest a better strategy to target different

types of consumers to influence their processing towards online advertisement.

## 2. Literature Review and Study Model

Advertising has been defined traditionally as "a form of controlled communication that attempts to persuade consumers, through use of a variety of strategies and appeals, to buy or use a particular product or service" [10, p.564]. It is also the "paid communication from an identified sponsor using mass media to persuade or influence an audience" [31, p.13]. Clearly, the central goal of advertising is to persuade consumers to purchase a product or service. Today, many new channels of mass communication are developed, exposing the public to an increasing number of mediated messages [11; 28]. Consumers are exposed to hundreds of advertising appeals delivered via television, magazines, newspapers, billboards, direct mail solicitation, e-mail, Internet banner ads and more. As a result, consumers have developed a more sophisticated understanding of the mass media and of advertising [5]. All of the above reasons create a greater challenge for advertisers to attract attention, especially thoughtful attention, to their messages either in traditional media environment or online environment.

Interactive advertising (IA) often means simply advertising on the Internet or online advertising [18]. Leckenby and Li defined IA as the paid and unpaid presentation and promotion of products or services by an identified sponsor through mediated means involving mutual action between consumers and producers [20]. IA technologies will be used to gather important consumer information, which will be accomplished through increased interactive means of asking questions (e.g., online surveys) and through more advanced forms of setting cookies and analyzing log files, keeping a record of interactive media experiences.

The ability, motivation, and opportunity (AMO) model in the consumer psychology literature suggests that ability, motivation, and opportunity provide frameworks theoretically to address strategies for effective communication with consumers [22; 15]. These three factors moderate or serve as antecedents to information processing by consumers and suggest that consumers engage in progressive levels of processing, ranging from superficial to deep processing [22; 15; 2; 3]. Motivation refers to "heightening arousal so that audiences are ready, willing, interested, or desire to process a message" and "represents a predisposition or preparedness to allocate

precious cognitive resources to processing information” [15, p.466]. Motivation can moderate the linkage between exposure, cognitive processing, and consequence of cognitive responses and attitude formation [22]. Ability refers to “the need to maximize an individual’s skills or proficiencies in interpreting a message” [15, p.466]. High-ability consumers who are knowledgeable about a topic can process information more efficiently and schematically than can novices [1; 15].

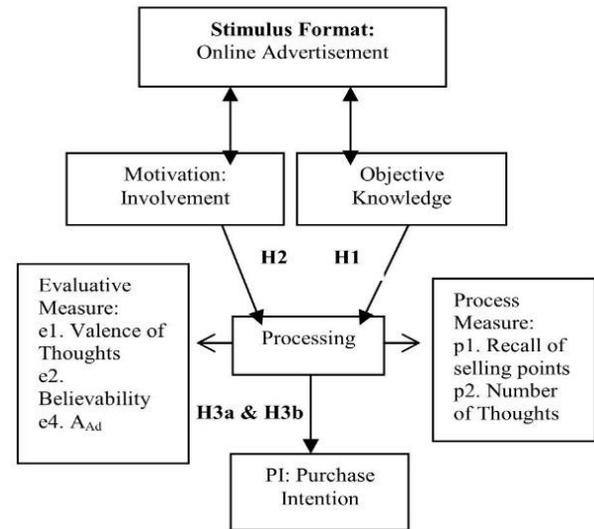
MacInnis and Jaworski offered a six-stage model that began with the feature analysis of message, followed by basic categorization of the message and topic, meaning analysis, information integration with personal experience, mental rehearsal, and mental construction of product attributes and benefits [22]. Certainly, the conceptual origin of emphasizing ability, motivation, and opportunity can be traced to the development of dual processing models in the social psychology literature including the Elaboration Likelihood Model (ELM) and the Heuristic-Systematic Model (HSM) [26; 8]. Both proposed that relevant message played a motivational role in the strategies consumers used to process advertising information.

Consumer knowledge can be defined as information that is learned, organized, represented, and stored in memory so it can be retrieved, used, and updated to create inherent, meaningful and useful property of the knowledge itself and make analogy, inference, reasoning, and elaboration regarding product messages [1; 16]. Consumer knowledge has two major components: familiarity and expertise. While familiarity accumulates from product-related experiences, expertise is defined relative to a performance criterion and implies increased ability to perform the product-related tasks successfully [1].

While definitions of consumer knowledge vary in the literature, the study uses the most common distinction that defined three types of knowledge, objective knowledge, subjective (self-assessed) knowledge, and product-related experience (familiarity). While three types of knowledge are usually correlated, the study uses subjective knowledge and objective knowledge as two different types of knowledge. “Subjective knowledge can be thought of as including an individual’s degree of confidence in his/her knowledge, while objective knowledge refers only to what an individual actually knows” [4, p.2]. The knowledge that consumers possess and the way it is organized lies at the heart of the understanding of consumer cognition. An understanding of what consumers know about products underpins what marketers and scholars of consumer behavior know about the processes, such as product preferences, attitudes toward brands, and purchase decisions.

An integrated model is illustrated in Figure 1. The model demonstrates that PI depends on consumers’ evaluative dimensions of processing information. The rationale for the conceptual framework is to separate the different influences from knowledge and involvement (motivation). In this case, the study can test how they independently influence information processing toward

consistent or inconsistent messages across the content types. The hypotheses with rationales are described in the following section.



**Figure 1: Conceptual Model**

Highly motivated consumers process information effortfully or systematically, whereas consumers with low motivation rely on cognitive shortcuts such as peripheral cues or heuristics. Central route or systematic processing is more enduring than persuasion that relies on peripheral route or heuristic processing [14; 21; 22; 26; 7; 8]. MacInnis, Moorman, and Jaworski suggested in-depth processing is desirable for two reasons: first, attention is likely to be modest as a result of too much information and distractions in the typical communication setting [21]. Second, enhancing levels of processing evokes more enduring memory and attitude change. It is possible that reading about high-involvement products led to lower recall and cognitive response scores because readers felt confident and saw no need to process the information more thoroughly. In this case, the study hypothesizes:

**H1: Medium-involved subjects are likely to have a better process measures toward the ads than low-involved subject.**

Ability refers to “the need to maximize an individual’s skills or proficiencies in interpreting a message” [15, p.466]. High-ability consumers who are knowledgeable about a topic can process information more efficiently and schematically than can novices [1; 15]. Objective knowledge is activated when the consumers feel the needs to [1; 16; 6]. When consumers are not motivated to process information, objective knowledge may not come into work since further processing is not desirable. In other words, the usage of objective knowledge should be evident when the expert not novice is motivated to process the information.

Even though it might be possible that low involved consumers have very high objective knowledge, they might

not be motivated to active the objective knowledge from long-term memory to comprehend and elaborate on the information. Brucks found that efficiency in information search could occur in attribute evaluation among knowledgeable consumers who only search useful information [4]. In this case, there is a negative relationship between knowledge and the possible number of message examined. On the other hand, “knowledge facilitation explanation” [4, p.4] could happen when the positive relationship between knowledge and the possible number of message examined. In this case, the inverted-U shaped relationship may result. Since there is possibility that both explanations could happen, it is hypothesized that:

**H2: Objective knowledge is related to evaluative and process measures of the ad. The relationship may be negative or positive.**

The proposed framework hypothesizes that purchase intention depends on positive evaluative measure responses, a function of valence of product-related thoughts, and attitude toward the ad. These evaluative measures and attitude mainly are affected by how subjects process the information. Given adequate ability, highly motivated consumers process information effortfully or systematically, whereas consumers with low motivation rely on cognitive shortcuts such as peripheral cues or heuristics. According to MacInnis and Jaworski [22], deep processing often accompanied communication exchanges in which the parties were fully engaged. However, because of consumers’ low objective knowledge about and low involvement in a topic, they were unlikely to engage in any more than superficial processing. Their processing of messages was likely to be limited to feature analysis, categorization, and elementary meaning analysis. In other words, subjects with low motivation and ability to process might be the group that is easier to be persuaded. In this case, the study hypothesizes:

**H3a: Purchase intention is increased by positive evaluative measure responses, a function of valence of product-related thoughts, and attitude toward the ad;**

**H3b: Among subjects who have high objective knowledge, purchase intention should be lower since they are more difficult to be persuaded.**

### 3. Methodology

Several sections of laboratory experiment were conducted to test the hypotheses, identified in the previous section. This section describes the sample, the experimental design, task, manipulations, and the constructs used to measure and test the hypotheses. To investigate the hypotheses, a 4 by 4 factorial design was employed. The 4 × 4 factorial design manipulated four levels of product involvement and four levels of objective knowledge. The product chosen for the study was a

tennis racquet. Tennis was selected because it was a product category that previous research studies used and proved to be a good product category for studying [6; 13]. Banner ad was selected as the advertising format because it is the most common usage and has proved to be successful and relatively easy to implement [9]. The power banner ad designed to communicate evidence of relative superiority claimed that the Head i.S6 has superb power for shots.

The size of online ad (550 by 240 pixels) was measured to be located at the central part of viewing range of the monitors. Since 24 computers at the lab were all the same type with exactly the same monitors, this nullified the possibility that subjects would have performed the experimental task differently due to different computers they used. With 19-inch monitor at the computer lab, the ad was shown to be in the center when subjects went to the homepage. Two hundreds and twenty one students were recruited from different levels of tennis class, beginning, intermediate beginning, intermediate, and advanced intermediate classes, taught at a large U.S. university. As an incentive for their participation, the subjects received credit points when they participated in the study.

The questionnaires were developed from the literature and using literature as guides to adapt, when necessary, to the specific focus of the study. Subjects first answered the first stage of recruiting questionnaire including measures of product involvement and objective knowledge. Measures of objective knowledge employed Moreau et al. [24] and Celsi and Olson’s [6] approaches including three questions, previously used by Celsi and Olson [6, p.217]. These questions can reflect subjects’ expertise regarding playing tennis. In addition, 12-item true-false questions were used to access subjects’ objective knowledge about selecting a tennis racquet (see Table 1). The highest score was 14 while the lowest score was 2 based on a possible range from 1-15.

**Table 1: Objective Knowledge Scores (4 Groups)**

	N	%	Mean	SD
Low Objective Knowledge	57	25.8	6.07 <sub>a</sub> ***	1.24
Low-medium Objective Knowledge	45	20.4	8 <sub>b</sub> ***	.00
Medium-high Objective Knowledge	77	34.8	9.51 <sub>c</sub> ***	.5
High Objective Knowledge	42	19	11.76 <sub>d</sub> ***	.88
Total	221	100	8.74	2.13

Note: Means that do not share a common subscript significantly differ. \*\*\* p < .000; F=455.291, df=3,217, p=.000

To measure the constructs of interest, the study also employed several multiple-item scales, used by other researchers and proved to have adequate reliability and validity. Subjects’ product enduring involvement scores were measured by Zaichkowsky’s [32] Personal Involvement Inventory (PII). Table 2 showed the possible three or four different levels of average involvement scores. The lowest average involvement score was 1 while the highest was 7.

**Table 2: Involvement Score (4 Groups)**

	N	%	Mean	SD	ANOVA
Low Involvement	55	24.9	2.84 <sub>a</sub> ***	.85	F=396.412 df=3, 217 P=.000
Low-medium Involvement	54	24.4	4.19 <sub>b</sub> ***	.19	
Medium-high Involvement	57	25.8	4.92 <sub>c</sub> ***	.20	
High Involvement	55	24.9	5.99 <sub>d</sub> ***	.43	
Total	221	100	4.49	1.25	

Note: Means that do not share a common subscript significantly differ.  
\*\*\* p < .000

Purchase intention was measured by a 7-point semantic differential scale from the lowest to the highest. Quality of information was measured by asking subjects whether the overall information presented in the ad was “accurate,” “truthful,” and “factual.” Believability and persuasion of the ad were measured by asking subjects whether the ad was “convincing” and “believable.” The study also used the measures of Advertising Message Involvement (AMI), proposed by Laczniak, Kempf, and Muehling [19] to form message involvement measures toward the ad. The items with 1-7 scaling included four components: (1) self-reported attention to the message claims, (2) perceived relevance of messages, (3) perceived engagement of messages, and (4) overall attention paid to the messages.

The numbers of selling points recalled from the messages were measured by the free-recall task. Each successfully recalled point was given a value of one and the sum of all points was the final score of recalled selling points for each subject. To qualify as recall of selling point, an examination of the recall data had to demonstrate memory of the key messages in the ad.

Product-related thoughts were measured by thought elicitation task in 3-minute period. After the thoughts elicitation task, a few questions were asked to determine whether the appeals in the ad were perceived to provide the best evidence of performance superiority (i.e., “Did the ad make you believe that tennis racquets provide increased power?”). Also, subjects were asked whether the appeals provided the information for making a better purchase decision (i.e., “Without considering specific message information, did the ad make you feel better about your decision?”). These questions were used as the general attitude toward the ad.

Control variables included attitude toward online shopping, credibility of Tennis Magazine and the questions regarding asking subjects’ past experiences of purchasing a racquet and playing tennis. Bipolar, 7-point semantic differential scales were used to measure all trust, believability, persuasion, and attitudinal measures ranging from 1 (low) to 7 (high) except the recall of selling points, number of the product-related thoughts, valance of the product-related thoughts. Subjects were asked to use their own words in 3 minutes to elaborate what are the messages they perceive from the ad regarding the i.S6. The recall of selling points were counted as how many selling points they mentioned. The product-related thoughts were numbered, counted, and evaluated by their valances. For example, if a subject had

three positive thoughts and one negative thought, his or her valance of thoughts would be 2 (3-1=2).

## 4. Data Analysis and Results

### 4.1 Manipulation Checks

The manipulation checks for reading the stimuli showed that subjects reviewed the ad without skipping under any condition. The manipulation checks for the ad showed all subjects in all conditions read them completely (100%).

### 4.2 Validity and Reliability of Measures

To assess the validity of measures, factor analysis with a Varimax rotation was conducted to verify that the items included in each construct loaded as expected without strong cross loading [29]. Table 3 contained the summary of the main constructs in the study, including descriptive statistics and the measure of reliability, Cronbach’s alpha. The results confirmed that all measures formed only one construct, which verified that the items loaded as expected without strong cross loading. All Cronbach alphas were larger than 0.82, indicating that all measures were reliable. The values of the constructs were computed as the mean of the ratings of the items, associated with each construct. No confounds were detected based on several demographic measures and control variables incorporated in the study including gender, major, education level, how much tennis subjects played, or whether subjects have purchased something online before. In this case, the data analysis focused on testing hypotheses by proposed experimental groups regardless of respondents’ gender, education level, and shopping experiences.

**Table 3: Summary of Descriptive Statistics for the Main Constructs**

Construct	Mean	SD	Reliability
<b>Independent Variable</b>			
Involvement score	4.49	1.25	0.97
Objective knowledge score	8.74	2.13	N/A
<b>Dependent Variable</b>			
Purchase intention	5.22	1.31	N/A
Message involvement	4.70	1.14	0.88
Recall of selling points	2.57	2.07	N/A
Number of thoughts	4.33	2.12	N/A
Product-related thoughts	3.37	2.30	N/A
Valence of Product-related thoughts	3.22	2.46	N/A
Quality of information	4.69	1.19	0.93
Believability	4.94	1.37	0.90
Attitude	4.77	1.28	0.82

### 4.3 The Effects of Enduring Product Involvement on Processing Online Advertisement

It was hypothesized in the study that medium involved subjects are likely to have higher process measures than low involved subjects. Support was found that more involved subjects did demonstrate the higher process measures to certain degree. The main effects of product involvement in Table 4 found main effects on the number of thoughts,  $F(1, 219)=5.017, p=.002$ , the number of product-related thoughts,  $F(1, 219)=4.802, p=.003$ , and valence of product-related thoughts,  $F(1, 219)=4.923, p=.003$ , generated by the ad. Results in Table 4 showed that subjects with medium-high involvement consistently had higher process measures toward the ad than the subjects with low-medium or low involvement. Highly involved subjects scored equal but not better process measures than subjects with medium-high involvement since highly involved subjects might not need the information or they considered that they already knew a lot. Subjects with medium-high but high involvement became the group that mostly engaged in the processing. The finding seemed to suggest that more involved subjects tended to engage in processing more until the need of information was demolished, which supported the hypothesis 1.

#### **4.4 The Effects of Objective Knowledge on Processing Online Advertisement**

It was hypothesized that when subjects are motivated to process information, objective knowledge is related to evaluative and process measures of the ad. The relationship may be negative or positive. The results found support for this proposition. The main effects of objective knowledge in Table 5 found no main effects evaluative measures, and post-hoc analyses found differences among means regarding the message involvement and the quality of information toward the ad. Subjects with high objective knowledge had lower evaluation of the ad than the subjects with medium-high objective knowledge. In other words, when the objective knowledge was low to medium, subjects were easier to be persuaded. When subjects' objective knowledge became the highest, they tended to evaluate the ad lower. In addition, subjects with high objective knowledge had lower message involvement toward the ad than the subjects with low-medium objective knowledge. This may mean subjects with highest objective might not think they need more information. In this case, the relationship is negative when the subjects have the highest objective knowledge regarding processing and evaluating the ad while the relationship is positive when the subjects have the low, medium or medium-high objective knowledge regarding processing and evaluating the ad.

On one hand, subjects with high objective knowledge might not need more information while subjects with low objective knowledge might not have the ability to process all the messages, explaining why the process and evaluative measures between subjects with high and low objective knowledge were not statistically different. On the other hand, subjects with high objective knowledge might not be easily persuaded since they have better

knowledge to evaluate the messages, supported by the evidence that subjects with high objective knowledge had the lowest purchase intention than other subjects (see Table 5).

#### **4.5 The Effects of Involvement and Knowledge on Purchase Intention**

As the study framework suggested, purchase intention would depend on several evaluative measures such as evaluation of the ad, believability of the ad, valence of product-related thoughts from the ad, and attitude toward the ad. The hypothesis 3a was supported as Table 6 revealed that subjects tended to use evaluation of the ad, the valence of the product-related thoughts perceived from the ad, and the attitude toward the ad to make their decisions.

The three components contributed significantly to the regression model ( $p=.000$ ) and suggested that when valence of the product-related thoughts perceived from the ad was positive ( $p=.021$ ) and the evaluation of the ad ( $p=.000$ ) and the attitude toward the ad ( $p=.018$ ) were high, subjects were inclined to have higher purchase intention. However, subjects with high objective knowledge might have low purchase intention. A negative valence ( $-2.406$ ) was placed on the coefficient of objective knowledge, which contributed significantly to the regression model ( $p=.017$ ). This suggested that when objective knowledge was high, the purchase intention was reduced, which supported the hypothesis 3b.

### **5. Discussion, Implication and Limitations**

There are companies that have created Web site and advertisements on the Internet today. They have done so simply because the competition has done so. Many think a poorly constructed Web site is better than no Web site at all. This mistake can cost the company missed business and disappointed customers. Just like a billboard or a magazine ad, consumers will bypass the digital advertising unless there is something available that is really useful and convincing to them. The AMO model is useful because it provides a theoretical umbrella for integrating a variety of otherwise disjointed communications tactics. Consumer research has shown that attitudes toward communications messages moderate attitudes about the products or services in promotional messages [22]. In this case, messages that strike affective responses generate more attention, greater interest, more cognitive responses, higher message recognition, and greater topic recall [25]. AMO model offers a potentially useful framework for conceptualizing and unifying otherwise seemingly disjointed message tactics that can be undertaken to communicate better with consumers. The results in the study provide advertisers with many opportunities of manipulating strategies in forming information based on the levels of consumers' product involvement and objective knowledge. With the significant customers in mind, key questions need to be answered are: will the consumers be motivated to process

the message? Is this issue relevant to the consumers? Are the consumers able to process the message? The answers to these questions will help decide whether a central or peripheral route would be more effective for message persuasion.

One limitation of this study is that the subjects did not actually purchase from the store: they advised a hypothetical friend about purchasing it. It is not clear whether conclusions reached by this study would apply to their own purchasing behavior. It might be that individuals with more at stake (i.e., their own money) would work harder at evaluating not just information but the whole site. The amount of time spent inspecting the message claims and the enthusiasm demonstrated by some of the subjects suggested however that this might not be a major threat to validity. Nonetheless, a study that tests subjects' real purchase behavior will be much more desirable.

Another technique to increase motivation, not studied here, evolves around enhancing the relevance of the message to individuals is the use of value-expressive appeals vs. utilitarian appeals. This technique has been shown to increase attention and message elaboration [17]. MacInnis and Jaworski [22] proposed several propositions regarding  $A_{Ad}$  and  $A_B$  based on utilitarian needs versus expressive needs. They proposed when the needs are utilitarian, negative feelings will be elicited by salient ad cues, utilitarian appeals, but need not have a negative impact on brand attitudes. However, there will be a negative effect on attitude toward the ad. When the needs are expressive, few negative feelings will be elicited by salient ad cues, expressive appeals. On the contrary, positive feelings will affect both brand attitudes and attitude toward the ad. In addition, they also proposed the "mediational effect of  $A_{Ad}$  on  $A_B$  will be weaker when the ad stimulates utilitarian versus expressive needs" [22, p.12]. Finally, MacInnis and Jaworski suggested "when needs are utilitarian (expressive) and the consumer is engaged in meaning analysis, salient cues that communicate the brand's ability to solve functional problems (that communicate emotional, symbolic, or ego-related meanings) will serve as heuristic indicators of brand benefits" [22, p.12]. The future study could incorporate all these factors to test the processing of advertisement.

## 6. Conclusion

The importance of the Internet is its interactive platform that introduces a new way of doing business to the world. The term "interactivity" is best defined as simply two-way communication, rather than merely a delivery mechanism [27]. The concept of interactive media has been developed through the idea of a hypertext medium that opens a new way of communication when, "hypermedia is multimedia with links among the components and a mechanism for moving along the links" [27, p.205]. This platform manipulates links between discrete pieces of information from one channel and synchronizes other information from other channels,

which helps advertisers to integrate information from different sources in real time, compared to traditional media. This advantage not only provides many promotional opportunities but also helps online shoppers exercise a certain degree of involvement with what consumers intend to purchase.

The change is so rapid that 1 year on the Internet is like 7 years in any other medium [23]. Now the concept of business communications has multiple and complex dimensions. As communication technologies evolve and browsing information becomes more interactive, personal, and sophisticated, advertising is being forced to evolve and integrated with other forms of communication as well. Due to advances in technology and production, it is very possible there will be no product advantages, no price advantages, no distribution advantages, and no location advantages. Competition will be based on customer information, customer service, and customer preference.

The Internet provides the technology to tailor shopping experience to the needs of the consumer. Advertising specialists are involved in the flow of online information where their consumers are looking for information. Today businesses find it necessary to concentrate on building long-lasting relationships with its consumers. The ability for two-way communication and the near instantaneous nature of the Web make the Internet the medium of choice for relationship marketing. Through carefully designed and coordinated programmatic studies, studies can help better understand how advertising messages generate a consumer's perception of a product or a service. Studies can also help better understand how factors such as motivation and knowledge can provide the basis for effective persuasion.

## References

- [1] Alba, Joseph & J. Wesley Hutchinson. "Dimension of Consumer Expertise," *Journal of Consumer Research*, 1987, 13 (March), 411-454.
- [2] Andrews, Craig. "Motivation, Ability and Opportunity to Process Information: Conceptual and Experimental Manipulation Issues," in *Advances in Consumer Research*, 1988, Vol. 15, Michael J. Houston, ed., Provo, UH: Association for Consumer Research, 219-225.
- [3] Batra, Rajeev & Michael L. Ray. "Situational Effects of Advertising Repetition: The Moderating Influence of Motivation, Ability and Opportunity to Respond," *Journal of Consumer Research*, 1986, 12 (March), 432-445.
- [4] Brucks, Merrie. "The Effects of Product Class Knowledge on Information Search Behavior," *Journal of Consumer Research*, 1985, 12 (June), 1-16.
- [5] Campbell, Richard. *Media and Culture*, 2nd ed., Boston, MA: Bedford/St. Martin's, 2000.
- [6] Celsi, Richard L. & Jerry C. Olson. "The Role of Involvement in Attention and Comprehension Processes," *Journal of Consumer Research*, 1988, 15 (September), 210-224.
- [7] Chaiken, Shelley & Durairaj Maheswaran. "Heuristic Processing Can Bias Systematic Processing: Effects of Source Credibility, Argument Ambiguity and Task Importance on Attitude Judgment," *Journal of Personality and Social Psychology*, 1994, 66, 460-473.

- [8] Chaiken, Shelley. "The Heuristic Model of Persuasion," in *Social Influence: The Ontario Symposium*, Vol. 5, Mark P. Zanna, James M. Olson, & C. Peter Herman, eds., Hillsdale, NJ: Lawrence Erlbaum Associates, 1987, 3-39.
- [9] Cho, Chang-Hoan. "How Advertising Works on the WWW: Modified Elaboration Likelihood Model," *Journal of Current Issues and Research in Advertising*, 1999, 21 (1), 33-50.
- [10] DeFleur, Melvin L. & Everette E. Dennis. *Understanding Mass Communication: A Liberal Arts Perspective*, Boston, MA: Houghton Mifflin, 1996.
- [11] Fitzgerald, K. "Picking through the Clutter, Media.Com Bids for Flawless," *Advertising Age*, 1999, 70 (8), 2.
- [12] Forrester Research. "eCommerce Will Prevail Through The Economic Downturn In 2002, According To A New Consumer Survey From Forrester Research," 2001, (November 7), available, [URL: <http://www.forrester.com/ER/Press/Release/0,1769,651,00.html>].
- [13] Gardner, Meryl P. "Advertising Effects on Attributes Recalled and Criteria Used for Brand Evaluation," *Journal of Consumer Research*, 10 (December), 1983, 310-318.
- [14] Greenwald, Anthony G. & Clark Leavitt. "Audience Involvement in Advertising: Four Levels," *Journal of Consumer Research*, 1984, 11 (June), 581-592.
- [15] Hallahan, Kirk. "Enhancing Motivation, Ability, and Opportunity to Process Public Relations Messages," *Public Relations Review*, 2000, 26 (4), 463-480.
- [16] Hoch, Stephen & John Deighton. "Managing What Consumers Learn from Experience," *Journal of Marketing*, 1989, 53 (April), 1-20.
- [17] Johar, J. S. & M. Joseph Sirgy. "Value Expressive Versus Utilitarian Advertising Appeals: When and Why to Use Which Appeal," *Journal of Advertising*, 1991, 20 (3), 23-33.
- [18] Kaye, Barbara K. & Norman J. Medoff. *Just a Click Away: Advertising on the Internet*, Boston, MA: Allyn and Bacon, 2001.
- [19] Laczniak, Russell N., DeAnna S. Kempf, & Darrel D. Muehling. "Advertising Message Involvement: The Role of Enduring and Situational Factors," *Journal of Current Issues and Research in Advertising*, 1999, 21 (1), 51-61.
- [20] Leckenby, John D. & Hairong Li. "From the Editors: Why We Need the Journal of Interactive Advertising," *Journal of Interactive Advertising*, 2000, 1 (1), available, [URL: <http://jiad.org/vol1/no1/editors>].
- [21] MacInnis, Deborah J., Christine M. Moorman, & Bernard J. Jaworski. "Enhancing and Measuring Consumers' Motivation, Opportunity and Ability to Process Brand Information from Ads," *Journal of Marketing*, 1991, 55 (October), 32-53.
- [22] MacInnis, Deborah J. & Bernard J. Jaworski. "Information Processing from Advertisements: Toward an Integrative Framework," *Journal of Marketing*, 1989, 53 (October), 1-23.
- [23] McGrath, Peter. "The Web: Infotopia or Marketplace?" *Newsweek*, 1997, (January 27), 82-84.
- [24] Moreau, C. Page, Donald R. Lehmann, & Arthur B. Markman. "Entrenched Knowledge Structures and Consumer Response to New Products," *Journal of Marketing Research*, 2001, 38 (1), 14-29.
- [25] Muehling, Darrel D. & Michael McCann. "Attitude Toward the Ad: A Review," *Journal of Current Issues and Research in Advertising*, 1993, 15, (Fall), 25-58.
- [26] Petty, Richard E. & John T. Cacioppo. *Communication and Persuasion: Central and Peripheral Routes to Persuasion*, New York: Springer-Verlag, 1986.
- [27] Rada, Roy. *Interactive Media*, New York: Springer-Verlag, 1995.
- [28] Shales, T. Quiet on the Set! A Modest Proposal for Television that Doesn't Assault the Viewer, *The Washington Post*, 1994, (July, 17), G1-G5.
- [29] Stevens, James. *Applied Multivariate Statistics for the Social Sciences*, NJ: Lawrence Erlbaum Associates, Inc, 1996.
- [30] Sujan, Mita. "Consumer Knowledge: Effects on Evaluation Strategies Mediating Consumer Judgments," *Journal of Consumer Research*, 1985, 12 (June), 31-46.
- [31] Wells, William, John Burnett, & Sandra Moriarity, *Advertising Principles & Practices*, 4th ed., Upper Saddle River, NJ: Prentice-Hall, 1998.
- [32] Zaichkowsky, Judith L. "Measuring the Involvement Construct," *Journal of Consumer Research*, 1985, 12 (December), 341-352.

**Table 4: Main Effects for Product Involvement**

	Product Involvement											
	All		Low		Low-Medium		Medium-High		High		F	P
	N=221	SD	N=55	SD	N=54	SD	N=57	SD	N=55	SD		
<b>Process measures</b>												
Message Involvement	4.70	1.14	4.70	1.21	4.52	1.07	4.77	1.09	4.79	1.18	.636	.593
Recall of selling points	2.57	2.07	2.40	1.67	2.13 a	1.80	3.16b**	2.34	2.55	2.28	2.526	.058
Number of thoughts	4.33	2.12	4.13	1.40	3.57	1.70	5.04	2.27	4.55	2.64	5.017	.002
			b***		b*		a		b*			
Product-related thoughts	3.37	2.30	3.22b*	1.78	2.61b***	1.89	4.21a	2.60	3.40	2.57	4.802	.003
<b>Evaluative measures</b>												
Quality of information	4.69	1.18	4.59	1.16	4.74	1.09	4.75	1.01	4.67	1.46	.227	.878
Believability	4.94	1.37	4.85	1.31	4.95	1.30	4.88	1.24	5.06	1.63	.259	.855
Valence of thoughts	3.22	2.46	3.07b*	1.87	2.46b***	2.04	4.18a	2.64	3.11b*	2.87	4.923	.003
Purchase intent	5.22	1.31	5.20	1.45	5.28	1.22	5.39	1.10	5.02	1.46	.776	.509

NOTES. Column: means that do not share a common subscript significantly differ; \*.<.05, \*\*<.001, \*\*\*<.000.

**Table 5: Main Effects for Objective Knowledge**

	Objective Knowledge										F	P
	All		Low		Low-Medium		Medium-High		High			
	N= 221		N= 57		N= 45		N= 77		N= 42			
	M	SD	M	SD	M	SD	M	SD	M	SD		
<b>Process measures</b>												
Message Involvement	4.70	1.14	4.58	1.36	4.99 b*	1.07	4.76	.99	4.41a	1.09	2.218	.087
Recall of selling points	2.57	2.07	2.40	1.94	2.44	2.11	2.55	2.02	2.95	2.29	.656	.580
Number of thoughts	4.33	2.12	4.19	2.01	4.16	2.03	4.31	2.04	4.74	2.48	.700	.553
Product-related thoughts	3.37	2.30	3.21	2.39	3.33	1.99	3.32	2.30	3.71	2.54	.414	.743
<b>Evaluative measures</b>												
Quality of Information	4.69	1.19	4.60	1.29	4.56	1.34	4.94 a	.89	4.49 b *	1.30	1.846	.140
Believability of the Ad	4.94	1.37	4.92	1.44	5.01	1.49	5.08	1.16	4.61	1.50	1.154	.328
Valence of thoughts	3.22	2.46	3.18	2.42	3.16	2.18	3.25	2.35	3.29	3.02	.029	.993
Purchase intent	5.22	1.31	5.37 b*	1.33	5.27	1.34	5.34 b*	1.05	4.76 a	1.61	2.214	.087

NOTES. Row: means that do not share a common subscript significantly differ; \*<.05, \*\*< .001, \*\*\*<.000.

**Table 6: Evaluative Measures on Purchase Intention**

Dependent Variable: Purchase Intention				
Cases =221, R-square =.62		Df=6, 214, F =22.475, P =.000		
Independent Variables	Beta	(Standardized	T	P
	Coefficients)			
(Constant)	***		5.706	.000
<b>Evaluation of the ad</b>	<b>.301 ***</b>		<b>3.597</b>	<b>.000</b>
Believability of the ad	.124		1.315	.190
<b>Valence of the product related thoughts from the ad</b>	<b>.131 *</b>		<b>2.329</b>	<b>.021</b>
<b>Attitude toward the ad</b>	<b>.190 *</b>		<b>2.375</b>	<b>.018</b>
Average Involvement Score	-.035		-.640	.523
<b>Objective Knowledge Score</b>	<b>-.130 *</b>		<b>-2.406</b>	<b>.017</b>

NOTES. Asterisks represent significance levels: \*\*\* p<0.001; \*\* p<0.01; \* p<0.05.

# Cyber-Marketing will Become the Mainstream of E-Commerce Development in Future

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## Abstract

In recent years, similar to what has happened in other parts of the world, electronic commerce (EC) in Mainland China has come through the great developing and changing. E-business is not only a tool for purchasing or buying, but also a marketing media for business. People combine the on-line marketing with off-line sales to develop their business. Cyber-Marketing will become the mainstream of EC development in future.

This paper reviews the development of China's EC, points out the impediments that impact EC developing in China, presents some surveys and statistics of EC in China, and analyses EC development's trends in future.

**Key Words:** Marketing; Electronic Commerce; Cyber-Marketing; Electronic Marketing; Electronic Business.

## 1. Introduction

As the fastest economic Development State in the world, China's EC and Network Economy develop very quickly in recent years. Similar to what has happened in other parts of the world, the EC development in China has experienced the following three phases.

First phase is the concepts importing and technologies developing stage from 1994 to 1997. In this phase, 1G mobile telecommunication system (mobile phone) and EC's concepts officially entered Mainland China. China's network economy began. National information infrastructure construct very quickly. The digital fibre cable and microwave network increased from 400000 km to 820000 km at the end of 1997, its geographic span from large cities to the whole country. The number of telephone users has reached 83.5 million, the number of mobile phone users has reached 13.23 million, the population of using Internet has reached 0.67 million.

Second phase is the quantity development taking off stage from 1997 to 2000. In this phase, China's digital

fibre cable and microwave network increased by 145%, from 820000 km to 1250000 km. The number of telephone users increased by 174%, from 83.5 million to 145.121 million. The ratio of Internet using population increased by 3359%, reached 22.5 million in the end of 2000. And the number of mobile phone users exceeded the United States, China become the largest mobile telecommunication market in the world.

Third phase is the China's EC booming stage since 2001. Although many pure "dot com" companies have closed down, many traditional enterprises begin to develop their on-line business. Business executives have understood the importance of cyber-marketing (on-line marketing). They combine the on-line marketing with off-line sales to develop the substantial business.

## 2. Review of EC in China

According to surveys conducted by some governmental, semi-governmental and non-profit Internet management and service organisation, such as Ministry Information Industry of China, Institute of Telecommunication Science Research, Internet Network Information Centre (CNNIC), there has been great increase in both aspects of the information infrastructure and application market.

### 2.1 NII Constructs and Applications

Table 1: China's NII Constructs from 1996-2000

	2000	1999	1998	1997	1996
Total	1250	1100	1000	820	130
Fiber Cable	286	239	200	150	39
Microwave	129.1	65.2	49.2	47.5	0

Unit: kkm

Source: CHINA E-COMMERCE YEARBOOK [2]

Table 2: Telecommunication investment from 1996-2000

2000	1999	1998	1997	1996
449.4	312	224.7	177.9	133.6

Unit: billion RMB

Source: CHINA E-COMMERCE YEARBOOK [1]

Table 3: Telephone development from 1996~2000

	2000	1999	1998	1997	1996
Telephone users	145.1	108.8	87.35	83.5	61.79
PBX	179	154	135	110	109
Long-distance Cable	3.7	2.3	1.63	1.24	1.038
Long-distance PBX	5.49	5.03	4.83	4.45	-
Telephone using Rate *	20.1	12.61	10.64	8.21	6.33
Telephone using Rate in City*	39	28.3	27.7	26.1	22
Telephone using Rate in countryside *	80%		67.1 %	55.6 %	

Unit: million

Note\*: telephone/100person

Source: CHINA E-COMMERCE YEARBOOK [3]

## 2.2 Internet Access and Development

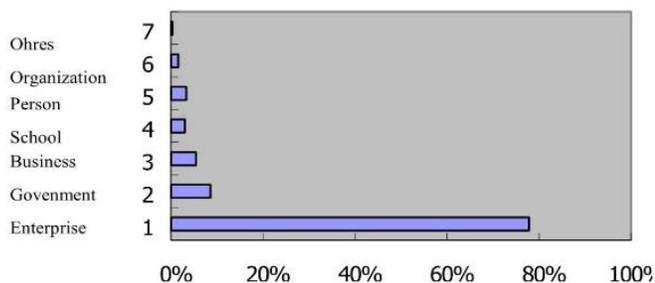
Table 4: Internet development from 1996~2000

	2000	1999	1998	1997	1996
Computer	22.00		11.00		5.00
On-line PC	8.92	3.5	0.75	0.33	0.029
Users	22.5	8.9	2.1	0.67	0.1
DoMain name (CN)	0.122	0.048 7	0.018 4	0.004 1	
Web Site	0.265	0.015 1	0.005 3	0.001 5	
Int. Capability	2799	351	143	25	

Unit: million

Source: CNNIC (<http://www.cnnic.net/>), 2001/3/31

Figure 1: Classify of Web site



## 3. Surveys and Analysis of EC Development

As time goes on, China's E-Commerce development has experienced drastic change since 2001. With the development of E-business, China's business executives understand that E-business is the business, IT must be combined with the traditional business. Substance industry enterprises understand the potentialities of EC, and become the mainstream of EC development, instead of pure "dot com" companies.

## 3.1 The Number of On-line Buyers isn't Increase

According to a survey conducted by CNNIC in July 2001, although the both number of Internet user and B2C web site have huge increase, the number of on-line buyer is nearly not on the increase.

Table 5: The Rate of people browser EC website (%)

	2000. 6	2000. 12	2001. 6
Always	72. 46	69. 07	73. 9
Sometimes	27. 54	30. 93	26. 1

Table 6: The rate of people bought something in Internet last year(%)

	1999. 12	2000. 6	2000. 12	2001. 6
Yes	8. 79	16. 28	31. 67	31. 9
No	91. 21	83. 72	68. 33	68. 1

Table 7: Satisfaction (%)

	2000. 12	2001. 06
Very good	1. 76	1. 8
Good	25. 96	27. 8
Ok	51. 24	50. 6
Bad	17. 17	16. 3
Very bad	3. 87	3. 5

Table 8: Most important problems (%)

	2000. 6	2000. 12	2001. 6
Secureraty	31. 76	31. 2	33. 4
Payment	13. 34	12. 59	11. 5
Quality, Service and Credit	28. 33	32. 03	33
Distribution	10. 14	9. 86	8. 7
Prise	7. 74	7. 39	6. 6
Information	7. 28	5. 91	6
Others	1. 41	1. 02	0. 8

Source: CHINA E-COMMERCE YEARBOOK [7]

## 3.2 Primary Obstacles

The primary obstacles impacting business to consumer (B2C) EC development in China are following 4 aspects. First is that the number of both people and stores are very great, B2C on-line sale can't show its advantages. Second is that both credit system and on-line payment system have been not established. Third is that the third part distribution (or physical distribution, logistics, supply chain) system is undeveloped. At last, there are not proper laws to protect it.

### 3.3 Enterprise Users and Scope are Increasing

According to the survey conducted by Information Centre of State Economy and Trade Committee (SETC) in 2001, the ratio that enterprise can access Internet is nearly 100%, and most large enterprises have business web sites and used the web sites to display their products and marketing strategies. [6]

According to another survey conducted by CCID Consulting, the EC scopes have reached 95.5 billion RMB in China in 2001. Thereof, 1% is from B2C and 99% from business to business (B2B). And there are much more enterprises using business web site to promote their products, provide the before or after sale services, create the customer relationship management system, and show enterprise's marketing strategies. [5]

### 3.4 E-Marketing

According to a questionnaire conducted by (SETC) in 2001, most of the managers are fairly optimistically thinking that E-marketing will develop very quickly in China. Nearly two-third of them predict that E-marketing would take off in China in the next two years and that combination of the on-line marketing and off-line sales will be the most promising one. These managers also feel that E-marketing is more suitable for China's business situations versus on-line sales. EC's major impacts on business seem to change idea, promoting products, on-line service, marketing expansion. [6].

### 3.5 The Driving Forces

The driving forces of recent EC market growth are expected to be the competitive compressive stress. Due to China acceding to World Trade Organization (WTO) and the trends of economy globalization, traditional enterprises have to use the Internet to develop their markets and business.

### 3.6 Current Advertising and Communication Media

The Respondents were asked about their firms' current advertising and communication channels and how satisfied they are with those channels in order to assess the potential of the Internet as a new medium for advertising and communication. About the thirty-nine firms reported their advertising mediums. Printed media is the most popular advertising media. Thereof, magazines are used by 23 firms and newspapers are used by 21 firms; billboards and TVs are used by 12 and 10 firms respectively. Most of the firms have not been very

satisfied with their advertisements because of a lack of promotion effectiveness (11), followed by high cost of advertisement (10) and limited contents of advertisements. Most of them think that Internet should have great potential to promote products and marketing strategies in the future. [9]

## 4. Conclusion

Based on survey results, some recent reports and the analysis in this paper, the summary of the e-commerce development in China are following:

### 4.1 China's B2C Market Can't Have Large Growth in Recent Years

Because the restrictive conditions that were depicted above can not be changed in recent years, the B2C market in China will not have large growth in recent years.

### 4.2 On-line Marketing Will Become the Mainstream of EC Development in China

With the growth of Internet population, more and more enterprises will use business web sites to show the marketing strategies, extend their market scope, provide their service and promote their products. The Enterprises will combine Internet and traditional trade way and create the most suitable way of developing China's EC.

Using Internet, mobile telecommunication and relative technologies to develop marketing will become the Mainstream of EC Development in Mainland China.

## References

- [1] China E-Commerce Yearbook, 2002, pp.28.
- [2] China E-Commerce Yearbook, 2002, pp.29.
- [3] China E-Commerce Yearbook, 2002, pp.30.
- [4] China E-Commerce Yearbook, 2002, pp.505~512.
- [5] China E-Commerce Yearbook, 2002, pp.514.
- [6] China E-Commerce Yearbook, 2002, pp.527~532.
- [7] <http://www.cnnic.net/>
- [8] Mingte Lu and Xuping Jiang, E-COMMERCE IN THE PRC: A PERSPECTIVE FROM BUSINESS EXECUTIVES. 1999 Asia Pacific Decision Sciences Institute Conference, Shanghai, June 9-12, 1999.

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# E-Business Investment in the Travel Industry: A Preliminary Study

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## Abstract

E-business has been rapidly growing in the retailing and service industries. As an innovative mode for selling and delivering products/services, e-business model involves both technological and strategic changes. It has been observed that firms in the same industry may adopt e-business model at different paces. Questions remain why some firms tend to actively implement e-business while others take cautious attitudes toward it. Scholars from different research fields have approached the innovation adoption issue from various theoretical perspectives. Drawing upon the innovation adoption literature as well as institutional theory, market orientation theory, and strategic choice perspective, this study proposes a multi-level explanatory model about e-business adoption in the travel industry. We identified some important environmental, organizational, and managerial variables that may affect e-business investment. Using survey data from a sample of travel agencies in Taiwan, we found that external competitive pressure, the firm's innovation orientation, its IT human resource base, the CEO's perception of e-business advantage, and CEO openness to experience were associated to e-business investment.

## 1. Introduction

In this study we define e-business broadly as an innovative business mode involving delivery of products / services, exchange of data / information, and financial payments through the Internet between the focal firm and its customers, suppliers, and other business partners. Using a sample of travel agencies, we intended to investigate the effects of some important environmental, organizational, and managerial factors on a service firm's involvement in e-business. Why some organizations adopt innovations while others do not has been an often-researched issue [7]. Previous researchers have approached to this issue from different theoretical perspectives, e.g., the innovation adoption / diffusion theory [8][9] and institutional theory [3][10][11]. A

significant suggestion of these research streams is that the variances among firms' adoption decisions could be fully captured only if the influential factors at multiple levels are taken into consideration [12]. There have been a large number of empirical studies on the adoption of such advanced IT systems as EDI [13][14][15], BITNET [16], integrated services digital network (ISDN) [17], and customer-based inter-organizational systems (CIOS) [18]. However, literature discussing the implementation of e-business model has been limited except for some case studies (e.g., [19]). This paper identified some critical factors that may influence a service firm's decision to implement e-business. We were especially interested in the so-called "traditional" firms' responses to the trend of e-commerce. Instead of trying to conceptualize a complete explanatory model, we identified specific antecedents of e-business implementation based on both theoretical literature and field interviews. Our purpose was to address the specific contextual factors with respect to the travel industry. Our pilot field work revealed that travel agency managers had different understandings of the prospect of e-commerce. It is interesting to explore three questions in this context: (1) Is the adoption of e-business model a symbolic / institutional action or an efficiency-driven decision? (2) Which type of market orientation is more closely related to e-business? and (3) How does the CEO's personal characteristics affect the firm's tendency toward e-business?

To answer the above questions, we developed hypotheses based on multiple theoretical perspectives and conducted a mail questionnaire survey in a sample of Taiwan-based travel agencies. We chose the travel industry as the research setting because this industry has seen probably the most striking impact of e-commerce. Travel agents have a long history of utilizing IS technologies and were among the first online retail businesses [1]. According to a Forrester Research survey, travel products sale accounted for 38 percent of the total online sales in 1999, which made the travel industry the largest online seller [20]. In Taiwan, an increasing number of Internet users and a thriving travel industry have pushed e-commerce to the central stage.

These trends make the travel industry of Taiwan an ideal setting to study e-commerce adoption.

## 2. Hypotheses

This study addresses the issue of e-business investment among travel agencies. A multi-level explanatory model is illustrated in Figure 1. Previous research has shown that organizational tendency for innovation adoption is influenced by a variety of factors [9][21]. One stream of research focuses on the characteristics of particular individuals within an organization (“champions” of innovation) and their influence on the development and adoption of innovative ideas. The other studies emphasize the effect of organizational factors such as organizational structure and business strategy [18][22] and environmental/institutional factors [3]. It is argued that the adoption of e-business model is a complex issue for the firms to handle because e-business involves significant investment in computer and networking technologies as well as human resources. As mentioned above, we did semi-structured interviews with a small sample of travel agency CEOs before the mail survey. Several themes repeatedly emerge from our interviewees’ descriptions about their own understanding of the determinants of e-business adoption. We organized these themes into three categories: environmental, organizational, and managerial factors. The research framework illustrated in Figure 1 reflects the pilot findings.

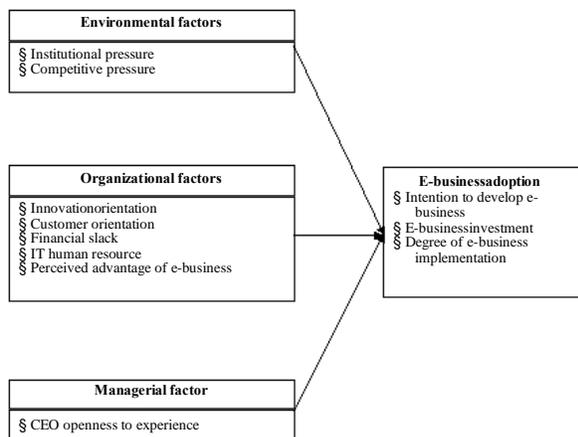


Figure 1. A multi-level model for e-business adoption

**Hypothesis 1:** The CEO’s perceived institutional pressure is positively related to the firm’s adoption of e-business.

**Hypothesis 2:** The CEO’s perceived competitive pressure is positively related to the firm’s adoption of e-business.

**Hypothesis 3:** Firms with a high level of innovation orientation are more likely to adopt e-business.

**Hypothesis 4:** Perceived advantage of e-business is positively related to the firm’s adoption of e-business.

**Hypothesis 5:** The more financial slack resource a firm

owns, the more likely that it will adopt e-business.

**Hypothesis 6:** IT human resources have positive effect on the firm’s adoption of e-business.

**Hypothesis 7:** A firm managed by a CEO with strong openness to experience is more likely to adopt e-business.

## 3. Research Method

### Research Setting

We chose Taiwan-based travel agencies as the research subjects. The travel industry has been regarded as having the biggest potential to do e-commerce. It is appropriate to test our theoretical model in the context of a single industry because single-industry studies would provide better control over inter-industrial differences and more precise identification of intra-industrial variances [61]. A single industry approach also avoids problems in variable definition and consequent comparability question of peer firms [62]. This is especially important for testing new ideas and identifying specific organizational and institutional factors.

### Pilot Study

We collected data through a large-scale questionnaire survey. Before the mass mailing of questionnaires, we conducted pilot interviews with travel agency CEOs for the purpose of obtaining in-depth understanding of the business environment and management practices of the travel agencies upon which we might improve the theoretical relevance of our study. The most important issue was to probe to what extent e-commerce had been introduced into the travel industry. Moreover, we asked the interviewees to describe the key factors related to the implementation of e-commerce.

We developed the initial questionnaire based on the pilot findings and a literature review. The factors mentioned by the interviewees were categorized and linked to similar theoretical concepts appearing in the theoretical literature.

### Data Collection

Our sampling frame was the member list of the Taipei Association of Travel Agents of 2000. Since it is a legal requirement that all registered travel agencies must join the above-mentioned trade association, the member list provides an ideal sampling framework. We randomly selected 500 travel agencies from the 961 member firms of the Association. The 10 firms we had interviewed in the pilot study were not included in the sample for questionnaire survey. Then we mailed questionnaires to the selected travel agencies. In order to increase response rate, the first author delivered some of questionnaires personally to the CEOs during a field trip to Taiwan.

We received completed questionnaires from 137 travel agencies. The response rate was 27.4%, which could be seen as acceptable for the large-sample, organization-level surveys [31][65]. We compared the responding firms and the non-responding firms on firm size (operationalized as

total capital) and did not find significant difference. So we felt it safe to say that no non-response bias was observed in our final sample of 137 travel agencies.

**Measurement**

The final survey instrument was a multi-item, Likert-type (5-point) questionnaire. We used subjective measures because our theoretical focus was on the manager’s perception of environmental and organizational contexts. Previous researchers have suggested that managerial subjective judgment about organizational contexts would accurately reflect the true situation in the organization. Moreover, top managers are well qualified to assess environmental and organizational factors related to innovation adoptions [12]. To measure the travel agent’s investment in e-business in terms of both human resource and financial resource commitments. The CEO was asked to answer two questions: (1) percentage of the employees whose jobs are related to e-business, and (2) investment in e-business as a percentage of the firm’s total assets. Considering that it may be difficult for the CEO to give exact numbers, we used a five-point scale to measure these two variables. A higher score represents a higher percentage. The average of the two items was used as the dependent variable -- *e-business investment*.

**4. Results**

The average history of the sample firms was 14.81 years (standard deviation = 10.04). The average employment size of the sample firms was 82 employees, with the largest firm hiring 600 people while the smallest firm hiring only 4 people. There were 94 Type A agencies and 43 general agencies.

Hierarchical regression analyses were performed to test the hypotheses. The results are showed in Table 1. We had tested two models; Model 1 includes only control variables and Model 2 includes both control and independent variables.

The results of hypotheses testing are displayed in the full model (Model 2). We did not find multicollinearity problem among IVs after examining the variance inflation factor (VIF) value corresponding to each independent variable (IV). All the VIF values were much lower than the threshold value of 10 [67]. Firm age does not have significant effect on the dependent variable (DV). Additionally, the general travel agencies appear to have moved further than the type A agencies in implementing online booking and payment systems.

As for the results of hypothesis testing, it is first noted that there is no significant relationship between institutional pressure and e-business investment. Thus H1 was not supported. It seems that innovation orientation has little to do with the firm’s “real” involvement in e-business measured as investment.

A positive relationship is found between perceived advantage of e-business and investment, providing strong support for H4. However, H5 is not support. The last organizational factor – IT human resource shows positive effect on the DV. These results support H6. Finally, H7 obtains partial support for CEO openness to experience is positively related e-business investment. Overall, the variance of each DV explained by the full model is significantly higher than explained by the control variables.

Table 1. Results of regression analysis

	E-business investment	
	Model 1	Model 2
Firm age	-.01	-.01
Firm size	.22	-.10
Firm type	-.12	-.10
Institutional pressure		-.06
Competitive pressure		.03
Innovation orientation		-.01
Customer orientation		.05
Perceived advantage of e-business		.29**
Financial slack		.07
IT human resource		.52***
CEO openness to experience		.22*
<i>R</i> <sup>2</sup>	.01	.34
<i>Adjusted R</i> <sup>2</sup>	-.01	.28
<i>R</i> <sup>2</sup> change		.33***

\* *p* < .05

\*\* *p* < .05

\*\*\* *p* < .05

**5. Discussion**

In this study we proposed a multi-level model about the factors influencing a service firm’s adoption of e-business. We measured e-business adoption as the level of investment in e-business a firm has committed. Our research framework is rooted in innovation adoption literature. Institutional theory, market orientation theory, and managerial strategic choice perspective were applied to explain how e-business adoption is influenced by different contextual factors. The hypotheses were tested in a sample of 137 travel agencies in Taiwan. The empirical findings are mixed. Two variables that consistently predict e-business adoption are the firm’s strength of IT human resources and the CEO’s perception of advantage of e-business. Finally, there is a positive linkage between the CEO’s personality trait (openness to experience) and the firm’s investment in e-business measured as both human resource and financial commitments.

**References**

(References are upon request)

# A Proposed Framework for Influencing Factors of Partnership in E-Marketplace

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## Abstract

This paper attempts to integrate concepts of e-marketplace and inter-organizational relationship to build a framework for influencing factors of e-business partnership and empirically explore it. The importance for five dimensions of the Research Model based on four top representatives of interviewed Taiwanese companies engaged in e-marketplaces is summarized. Fuzzy Delphi Method is used to decide which factors are vital for the success in three phases of partnership in e-marketplace. Data are collected through a survey of organizations that are actively involved in the planning or operation of e-marketplaces. Except exploiting of new market, the result has been shown the influencing factors are not the same in three phases of partnership in e-marketplace. It implies that to manage an e-marketplace must have different strategies to select, develop, and maintain participants.

## 1. Introduction

In the past years, many organizations have tried to expand or broaden their supply chains in e-marketplaces. However, successful e-marketplaces are rare until now, it maybe partly dues to the Internet stock slump making financing much more difficult for e-marketplaces, but organization behavioral adjustments should be also considered. Transitioning from traditional transaction approaches to an e-business model and adopting new technology present many organizational challenges. Building an Internet infrastructure and attracting more participants initially may not ensure the longevity of an e-marketplace.

Therefore, this research tries to cover the findings of studies on e-marketplaces and organization behaviors. The research methodology is comprised of three approaches:

1. Literature review for building a Research Model.

2. Interviews with top-level executives in leading Taiwanese companies engaged in e-marketplaces to validate and justify the Research Model.
3. Questionnaire Survey based on the Research Model and Fuzzy Delphi Method to explore the critical influencing factors of e-business partnership.

Goal of this research is hence to present the Research Model for influencing factors of partnership in e-marketplace. These factors may create valuable information for e-marketplace administrators to build appropriate strategies for their businesses.

## 2. Literature Review

Within the literatures, it is shown that appropriation of information technology such as e-marketplaces justifies organization behaviors[5]. As to the relationship styles of business partners, scholars propose many types such as arm's length, joint venture, supply chain and so on[2,4,8,9,10,12,17].

Two major schools of thought have pursued the study of information technology and organizational changes. The decision-making school[14] emphasizes the cognitive processes associated with rational decision making and adopts a psychological approach to the study of technology and change. Institutional school[11,13] emphasizes the role of ongoing discourse in generating social constructions of technology, with a consequent emphasis on human interaction in studies of technology effects. Several theoretical views synthesize these competing schools to form the social technology perspective. Adaptive Structuration Theory (AST) proposed by DeSanctis and Poole[5] in 1994 provides a model that describes the interplay between Advanced Information Technology (AIT), social structures, and human interactions. AST focuses on social structures, rules and resources provided by technology and institutions as

the basis for human activities.

The constructs of AST[5] are (1) structure of AIT including structural features and spirit, (2) other source of structure including task and organization environment, (3) group's internal system including styles of interacting, knowledge and experience with structures, perceptions of others' knowledge and agreement on appropriation, (4) emergent sources of structure including AIT outputs, task outputs and organization environment outputs, (5) new social structures including rules and resources, (6) social interaction including two subsets: (a) appropriation of structures including appropriation moves, faithfulness of appropriation, instrumental uses, and persistent attitudes toward appropriation, and (b) decision processes including idea generation, participation, conflict management, influence behavior and task management, and (7) decision outcomes including efficiency, quality, consensus and commitment.

AIT brings social structures which enable and constrain interaction to the workplace. E-marketplace is one type of AIT for the modern organizational market; it combines computing, communication, and business trading decision support capabilities to aid in buyer-seller groups idea generation, planning, problem solving and choice making. Within the e-marketplace literatures, technology designs put computer systems to support business tasks, such as billing, inventory management, financial analysis, report preparation, coordination among people and provide procedures for accomplishing interpersonal exchange.

Structural features are the specific types of rules and resources, or capabilities offered by the system. Features within e-marketplaces might include anonymous recording of business transactions, periodic data collecting and analyzing, and negotiation within business groups. Those features govern exactly how information can be gathered, manipulated, and managed by members in e-marketplaces. Features of e-marketplaces bring meaning and control to group interaction. There currently is burgeoning interest in e-marketplaces and their potential role in facilitating organizational and social changes. Once e-marketplaces are applied, the technology should bring productivity, efficiency, and satisfaction to individuals and organizations, but the social evolution of structure within industrial and human institutions are also changing. Social technology perspective as AST can be an analytic principle to explore the influencing factors for e-marketplaces. Based on the meaning of each construct in AST, initial dimensions for the Research Model are listed as Table 1.

### 3. Research Model

Researches related to e-marketplaces focus on finding characteristics and functions. The findings in literatures

Table 1. Initial Research Dimensions inspired from AST

Major Constructs of AST	Initial Dimensions for the Research
Structure of AIT	Characteristics of e-marketplaces
Other Source of Structure	Administration of e-marketplaces
Group's Internal System	Members of e-marketplaces
Emergent Source of Structure	Market Environment
New Social Structure	Derivative Problems of e-marketplaces
Appropriation of Structure	Functions of e-marketplaces
Decision Process	Phases of Partnership in e-marketplaces

include information gathering, buyers-sellers matching, transaction efficient, supply chain integration, cost reduction, etc[1,3,7,15,16]. The influencing factors of each dimension are summarized in Table 2.

The relationship styles of buyers-sellers in organizational markets proposed as five relationship styles of partnership in e-marketplaces are also defined. They are (1) arm's length, (2) buyer-seller relationship, (3) trusted partnership, (4) joint venture and (5) value chain. Expert depth interview is employed to validate the Research Model. Then a primary questionnaire survey is conducted to analyze which influencing factors are vital for the success in three phases of partnership in e-marketplaces, including a question about the relationship styles of partnership in e-marketplace in order to exploit participants' perspectives.

Four top representatives of Taiwanese companies related to e-marketplaces are selected for expert depth interview to validate the Research Model. The companies interviewed are DRAMeXchange, Liet-On eCommerce, Universal Exchange, and Oracle Taiwan. The actors of these four companies in e-marketplaces are neutral, buyer-oriented, seller-oriented, and technology provider, respectively. The importance of each research dimension based on opinions of four executives of the interviewed companies is summarized in Table 3. The importance of five out of six research dimensions are bigger than 75% that is set to be significant (i.e. significant dimensions

Table 2. Influencing Factors of Research Dimension

Research Dimension	Influencing Factors
Characteristics of e-marketplaces	(1)buyer-seller gathers (2)information gathering (3)information transparency (4)efficiency
Administration of e-marketplaces	(1)professional knowledge (2)credibility (3)capacity of information integration (4)providing of service integration (5)providing characters of commodity for transactions
Market Environment	(1)characters of industry (2)degree of computerization (3)promotion of pioneers
Derivative Problems of e-marketplaces	(1)reform of business procedures (2)reform of organization structure (3)degree of information transparency (4)security of online payment (5)standards of commodity
Functions of e-marketplaces	(1)styles of e-marketplaces (2)mechanism of matching (3)cost reduction (4)expansion of new channels (5)risk control (6)inventory control (7)integration of supply chain *(8)Information obtaining *(9)exploiting of new market
Phases of Partnership in e-marketplaces	(1)selecting of partners (2)developing of partnership (3)maintenance of partnership

\* proposed by four interviewed representatives.

Table 3. Importance of Research Dimension

Research Dimension	Number of factors mentioned by experts	Sum of importance among factors	Importance of dimension
Characteristics of e-marketplaces	15	16	94%
Administration of e-marketplaces	19	20	95%
Market Environment	11	12	92%
Derivative Problems of e-marketplaces	19	20	95%
Functions of e-marketplaces	27	36	75%
Phases of Partnership in e-marketplaces	6	12	50%

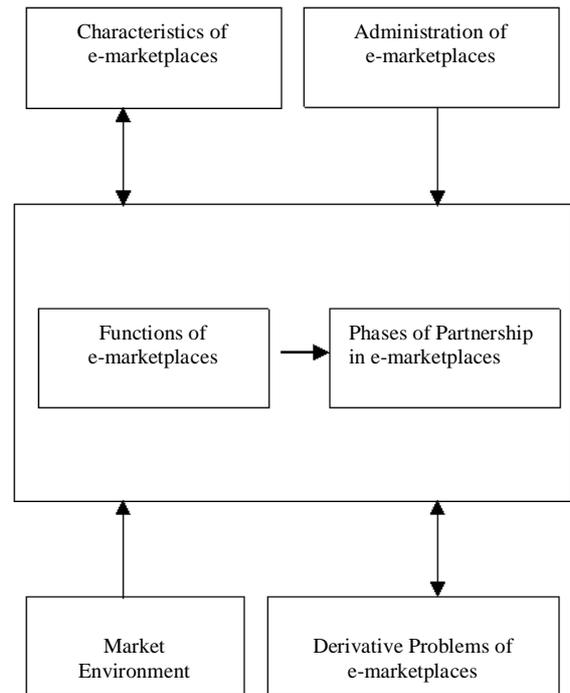


Figure 1. Research Model

must have three out of four interviewees mention at least). Based on the importance recommended by four executives, the Research Model is proposed as Figure 1. Information obtaining and exploiting of new market are two additional factors proposed by four interviewed representatives.

#### 4. Primary Questionnaire Survey and Research Findings

Since the Research Model is justified and validated, the questionnaire survey is deployed next. In the questionnaire, fifty questions are developed for twenty-six influencing factors of five dimensions in the Research Model. Items appearing in the question are measured in five-point Likert-type scales. Data are collected through a survey of organizations that are actively involved in the planning or operation of e-marketplaces. Twenty-five questionnaires are delivered. Eighteen are recycled and considered effective after examination. For avoiding bias from extreme values, Fuzzy Delphi Method uses geometric means instead of average means to evaluate answer values of questionnaire surveys. This research is hence to use Fuzzy Delphi Method to decide which factors are vital for the success in three phases of partnership in e-marketplace.

The geometric mean of answer values to each question is converted into percentage form. Questions with the percentage bigger than 75% are considered significant in this research. Influencing factors related to those significant questions are the crucial factors this research aims to find. According to the primary analysis, the crucial influencing factors of three phases of partnership in e-marketplace are summarized in Table 4.

Table 4. Crucial Influencing Factors of Partnership in E-marketplace

Phase	Selecting Of Partners	Developing of partnership	Maintenance of partnership
Factor	Cost Reduction	Characters of industry	Expansion of new channels
	Credibility	Exploiting of new market	Exploiting of new market
	Information gathering	Efficiency	Credibility
	Information obtaining	Information gathering	Standards of commodity
	Exploiting Of new market	Buyer-seller gathers	Characters Of industry

## 5. Conclusion

The research findings have been shown the influencing factors are not the same in three phases of partnership in e-marketplace, except exploiting of new market. These factors are dispersed in different dimensions (as shown in Figure 1). The research findings imply that to manage an e-marketplace must have different strategies to select, develop, and maintain participants.

As to the prospective relationship style of partnership in e-marketplaces, experts involved in the questionnaire survey regard e-marketplace transactions as the traditional ones. organizations involved in e-marketplaces only put their supply chains on Internet to make transactions more efficient.

Small sample size is one of the limitations of this research. A larger-scale questionnaire survey is expected to be conducted in the future to verify and enrich the primary research findings. Also factor analysis is going to be used for finding the vital research dimensions.

## References

- [1]. Bailey, Joseph P. and J.Y. Bakos, "An Exploratory Study of the Emerging Role of Electronic Intermediaries," *International Journal of Electronic Commerce*, Vol.1, No.3, Spring 1997.
- [2]. Bensaou, M., "Portfolios of Buyer-Supplier Relationships," *Sloan Management Review*, Summer, 1999, pp.35-44.
- [3]. Berryman, Kenneth, Lorraine Harrington, Dennis Layton-rodin and Vincent Rerolle, "Electronic Commerce: Three Emerging Strategies," *The McKinsey Quarterly*, No.1, 1998, pp.152-159.
- [4]. Bowersox, D.J. and C.M. Bixby, *Strategic Marketing Channel Management*, McGraw-Hill Book Co., 1992.
- [5]. DeSanctis, Gerardine and Marshall S. Poole, "Capturing the Complexity in Advanced Technology Use: Adaptive Structuration Theory," *Organization Science*, Vol.5, No.2, May, 1994, pp.121-147.
- [6]. Jap, Sandy D., "Perspectives on Joint Competitive Advantages in Buyer-Supplier Relationships," 2000. <http://web.mit.edu/snadyj/www/>
- [7]. Kaplan, Steven and Mohanbir Sawhney, "E-Hubs: The New B2B Marketplace," *Harvard Business Review*, May/June, 2000.
- [8]. LaLonde, B.J. and M.C. Cooper, "Partnerships in Providing Customer Service: A Third Party Perspective," *Council of Logistics Management*, 1989.
- [9]. Lambert, Douglas M., Margaret A. Emmelhainz and John T. Gardner, "Developing and Implementing Supply Chain Partnerships," *The International Journal of Logistics Management* Vol.7, No.2, 1996.
- [10]. Maloni, Michael J. and W.C. Benton, "Supply Chain Partnerships: Opportunities for Operation Research," *European Journal of Operational Research*, 1997, pp.419-429.
- [11]. Markus, M. L. and Robey, D., "Information Technology and Organizational Change: Causal Structure in Theory and Research," *Management Science*, Vol.15, No.5, 1988, pp.583-598.
- [12]. Mclvor, Ronan and Marie McHugh, "Partnership Sourcing: An Organization Change Management Perspective," *The Journal of Supply Chain Management*, Summer, 2000, pp.12-20.
- [13]. Orlikowshi, W. J., "The Duality of Technology: Rethinking the Concept of Technology in Organizations," *Organization Science*, Vol.3, No.3, 1992, pp.398-427.
- [14]. Perrow, C., *Complex Organizations: A Critical Essay*, 3<sup>rd</sup> ed. New York: Random House.
- [15]. Segal, Robert L., "Online Marketplaces: A New Strategic Option," *Journal of Business Strategy*, March/April, 2000, pp.26-29.
- [16]. Strader, Troy J. and Michael J. Shaw, "Characteristics of the Electronic Markets," *Decision Support Systems*, Vol.21, 1997, pp.185-198.
- [17]. Stuart, F. Ian, "Supplier Partnerships: Influencing Factors and Strategic Benefits," *International Journal of Purchasing and Materials Management*, Fall, 1993.

# Winning in Digital Economy

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## Abstract

Even in best of the times, big companies find it difficult to sustain in the market with the same line of products. There is always a threat from the competitors and the new entrants of the market, engaged in creating new businesses and products. With the coming of digital age & fierce competition, breathing space of company is reduced to minimum. Managers of old industrial companies are sending SOS calls and looking forward for new business models. The need of the time is to listen to the survival calls for the 'clicks-and-bricks' business model that blends the traditional off-line assets with digital initiatives. The Internet is encouraging a shift from industrial age "brick and mortar" strategic thinking to a greater emphasis on the use of alliances.

### 1. E-enabled enterprise.

"NCR is a 117 year old company. We learned that new-economy people did business in other ways. They forced us to think out of the box, and that was a good thing. It's healthy for an old company to think that way. It's one of the biggest challenges in keeping an old company vibrant..."

- Lars Nyberg, Chairman & CEO, NCR Corp.

Value net as, Michael Porter puts are Customers, Competitors, Suppliers and Complementors with your firm in the center. The question is how to leverage our value net to create and capture value. The only way to create and capture value is to strategically transform the old economy traditions to new economy applications. The new e-enabled enterprises abide by e-transformation issues of Customer Relationship Management (CRM), Supply Chain Management (SCM), E-Commerce and Knowledge Management (KM). These new e-transformation themes offer different value propositions.

Customer Relationship Management (CRM) draws emphasis on to identify, select, acquire, develop and retain our most profitable customers. Digital economy companies strongly believe in buyers market. CRM not only addresses personal preferences, value and need of the customers but also builds customer loyalty through acquisition, development and retention.

The essence of the SCM is to deliver the right product, to the right place at the right time at the lowest cost. Implementing the principals of SCM provides end-to-end seamless capability in the supply chain, which in turn, results in improved customer relations and lower inventory levels. E-commerce is more than just trading on net. Internet acts as medium to deliver a more higher quality interaction to suppliers, distributors and customers. E-commerce facilitate in expanding business opportunities by reaching new markets, reducing cost via order processing efficiencies, maintaining fills rate while reducing inventory expenses and lowering cost of sales.

Knowledge Management (KM) is defined as "Management of organizational knowledge for creating business value and generating a competitive advantage". KM is the process of delivering the right knowledge to the right people at the right time to leverage expertise and information to improve the organizational performance. The main focus of KM is to acquire, analyze, store, disseminate and enrich knowledge throughout the enterprise.

In addition the e-marketplaces establish new trading models in vertical and horizontal markets. Online catalog digitalized product information in paper-based catalogs of multiple vendors and provide one stop shopping over the net and also allows buyers to search for products more efficiently. E-Auctions provides venues for the purchase and sale of new items where pricing is dynamic. E-Exchanges allows buyers and sellers to trade anonymously and provide a spot market for commodities, often with high price volatility. E-Communities bring together potential buyers and sellers, usually professionals with common interests, through web sites that feature industry specific content and community aspects. They typically provide industry specific news, editorials, market information, job listings, chat, message board etc. So the importance is to build an enterprise e-business framework that encompasses all touch point of the organization i.e. customers, vendors, people, alliances, stockholders etc.

Currently, five e-business themes are driving business strategies and initiatives.

1. Enhance operational efficiency.
2. Improve customer access, service, delivery and intimacy.
3. Redesign product and service offerings.
4. Reinforce brand image and company image in the marketplace.
5. Reinvent services, product and/or business.

## 2. Moving up in Value Chain.

“My favorite misread was the idea that business fundamentals had changed – that the traditional ways of doing business didn’t matter anymore: If you sold enough product or enough items at a loss, eventually you’d make a profit...”

- Warren Holtsberg, VP, Motorola Inc.

Every organization can move up in the value chain by reducing cost, improving process, redefining processes, redefining business models and creating new markets. Cost reduction can be done by introducing intranet for employee self-service and providing online support to the sales force rather than calling them to the office again and again.

Processes can be improved by providing online customer support and procuring via net (e-procurement). Vendor management inventory, strategic sourcing initiatives and selling products through e-channels can be some processes, which can be redefined.

It’s prominent to give services free with sale of product. In Networked economy, the business models need to be redefined. Customer should learn to pay for service like wise manufacture rather than producing itself everything should outsource production.

Creation of new market is another aspect, which is most important in value chain. Companies should identify opportunities and become market maker. They should invent new markets through e-channels and leverage their intangible assets.

An organization can adopt e-business strategies at any point in business cycle.

Stages of Business Life Cycle	E-Business strategies
Introduction	e-presence <ul style="list-style-type: none"> <li>• Use the Internet internally.</li> <li>• Establish a website.</li> </ul>
Growth	e-transaction <ul style="list-style-type: none"> <li>• Allow access to core systems.</li> <li>• Allow transactions on core systems.</li> </ul>
Maturity	e-business <ul style="list-style-type: none"> <li>• Improve core business processes.</li> <li>• Redefine core</li> </ul>

	business.
Decline	e-transformation <ul style="list-style-type: none"> <li>• Reinvent Business models.</li> <li>• Redefine products/services, add value.</li> </ul>

Readiness and integration are two important issues that must be considered when pursuing an overall e-business transformation. Managers should first find out that their business is robust enough and sufficiently ready to take advantage of e-business. Second issue is of integration of business processes to maximize investment in e-business initiatives.

## 3. From E to E.

There is a wonderful Chinese saying, “Journey of 1000 miles began with a small step”. Succeeding in digital economy calls for a different resolve. Create Energy that drives the organization, Energize the team, Empower your colleagues, create Edge in market with new product innovation, Execute your plans with simplicity and speed, follow Ethical business practice, give Equity to stockholders, Encourage mistake and learning, Examine ones mental model, Experiment for continuous improvement, Educate others like top management on technology and inside of organization on customers and have Environmental concerns.

### 9P FORMULA for winners

1. Knowledge is the key.
2. New Business hrs. 24x7x365
3. Everyone and everything will be networked.
4. Everything will be smart.
5. The customer is in charge.
6. Time is the scarcest resource.
7. Barriers to competitive entry are lower then ever.
8. Constant innovation is an ingenious tactic.
9. Follow rule 1 to 9 or become extinct.

## References

- [1] Jurgen, Wolfram, Thomas. “ Knowledge Unplugged: The Mckinsey & Company global survey on Knowledge management”. 2001
- [2] Thomas H. Davenport and Laurence Prusak, “ Working Knowledge: How Organizations Manage What They Know”. P. 163, Harvard Business School Press, Boston.
- [3] Agarwal Nikhil, Sherry A. M, “ Knowledge Economy: A Strategic Economic Transformation”. Paradigm (July-Dec), 2001

- [4] Stefan Thomke and Eric Von Hippel, "Customers as Innovators: A new way to create value". Harvard Business Review April 2002. pg. 74-81.
- [5] World Development Report 2002
- [6] Kotler, Philip, "Kotler on Marketing: How to create, win and dominate markets". New York: The Free Press 1999.
- [7] M.E. Porter, "Competitive Advantage creating and sustaining superior performance". New York: The Free Press 1985.
- [8] J.K Lee, "Next Generation Electronic Marketing Environments ICEC Perspective". Proceedings of International conference on Electronic Commerce' 98, 1998 ([www.icec.net](http://www.icec.net))
- [9] A.K Maitra, "Building a corporate Internet strategy". New York: Van Nortand Reinhold 1996.
- [10] P.Rubber, "Getting smart with Business Intelligence". Beyond Computing June 1998.
- [11] W.Mougayar, "Opening Digital Markets: 2<sup>nd</sup> ed. New York: Mc Graw Hill [with Commerce Net Press] 1998.
- [12] Phil Orbanes, "Everything I know about Business I learned from monopoly". Harvard Business Review 2002.

# 'Do It Yourself (DIY)' E-Business Solutions for Small and Medium Enterprises

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## Abstract

The potential benefits and cost of adopting and implementing e-business solutions are both high. They are major attraction and concern for Small and Medium sized Enterprises (SMEs) respectively. If a right tradeoff point is not balanced between the two, a breakthrough progress is unlikely to become true. This paper addresses this very issue by proposing and developing a new approach based on the concept of "portalets" that are used as building blocks to develop e-business solutions with no or varying degree of customization efforts. Portalets are designed following the platform for deriving the software product lines. This "Do It Yourself (DI)" approach significantly reduces the time and effort to an affordable level while capturing the unique business logics into the solutions. In this paper, the necessity, feasibility, and the challenging issues of the proposed DIY e-business approach will be discussed. Case studies will be presented to demonstrate the approach and directions for further work.

**Keywords:** Enterprise portal, e-business, Do It Yourself (DIY), Digital enterprises, Small Medium Enterprise (SME).

## 1. Introduction

In recent years, the importance of Internet and World Wide Web (WWW) technologies in manufacturing industries has been rising very rapidly in a global context, the impact of which is deemed most profound ever since the Industrial Revolution (Manufacturing Foresight 2020). The waning interests in the electronic commerce and electronic business (e-commerce / e-business) have spread, from the heartland (product development) to the battlefield (shop floor), of manufacturing enterprises. The technology gradually transforms traditional manufacturing to what can be referred to as Digital Manufacturing (or e-Manufacturing), with more companies using the Internet to get into new markets, increase supply chain efficiency, create new value chains, and increase the efficiency of internal planning and operations.

The number of web applications is ever on the rise, and many practitioners are keen on trying these remote systems through web browsers to support their decision-making activities. Indeed, product design and manufacture professionals will soon be able to benefit from such remote services and supports commercially available on the Internet. The practice and performance of product development and realization are expected to make immense progress. Web applications in product design and manufacture signals the beginning of a new era of the digital manufacturing enterprise.

Although the Internet technology has the potential of enhancing a company's competitiveness, it has also created a new challenge for the manufacturing industry. Manufacturing companies have just been persuaded to invest in Information Technology (IT) and Information Systems (IS), and have made appropriate changes to accommodate and adapt to these technologies. Now these information systems are becoming legacies even before their capabilities have been fully exploited. Now their roles have to be performed under the Internet and web environment. Hence, manufacturing companies have difficulties in formulating the most appropriate investment strategy in IT and IS under such rapidly changing environment.

In addition, the adoption of the web-based manufacturing approach is not only the decision of the manufacturers. If the customers, suppliers, and the commercial and financial sectors prefer to adopt the web approach, the IT industry will provide various web applications to meet their requirements. Eventually, most decision-support systems (DDS) for the manufacturing industry will also become web-based. They will then have to incorporate some or many of their business activities, decisions, and operations into web applications.

The potential benefits and cost of adopting and implementing e-business solutions are both high. They are major attraction and concern for Small and Medium sized Enterprises (SMEs) respectively. However, SMEs are generally unclear about which approach should be adopted to introducing the e-business solutions (EBS). This paper is in favour of the so-called DIY (Do It Yourself) approach, meaning that SMEs designing, developing, deploying and maintaining their own EBS. The rationale behind this DIY approach is only valid on the assumed emergence of the concept of "portalets" which are ready made constructs to facilitate the EBS design, development, deployment and maintenance. This paper will discuss the necessity and feasibility of the portalet-based DIY approach to EBS.

The remainder of the paper is arranged as follows. Section 2 presents a typical scenario that motivates this research, highlighting the major issues. Section 3 articulates the concept of Digital Enterprises in general and Digital Manufacturing (Enterprises) in particular. Typical approaches to EBS are discussed in Section 4 to highlight the necessity of the proposed approach. Section 5 demonstrates the feasibility of the proposed approach from a number of aspects. The concept of "portalets" is briefly introduced in Section 6. Section 7 focuses on the case study on the "TreeTable" portalets which have been widely in a variety of EBS.

## 2. Motivating Scenario

Let us first imagine a typical manufacturing enterprise that has enjoyed a rapid business expansion from a much smaller scale two decades ago to the present medium-sized scale. The company was created in Hong Kong as a family business in early 1960s and enjoyed a steady development by serving the US and European markets during 1970s.

The company took advantage of the Mainland China' open door policy since early 1980s and moved most of its manufacturing facilities to the Peal River Delta while keeping its headquarter in Hong Kong to accommodate production-related logistic activities such as purchasing, marketing, product development. Because of much cheaper labour and raw materials in Mainland China, relatively fewer competitors and growing US and European markets, the business had enjoyed a rapid development during 1980s and 1990s.

Like most of the other manufacturing enterprises, the company invested in Information Technology and Information Systems (IT/IS) mainly to support operations of routine business processes. The Computer Aided Design and Manufacturing systems have been routinely applied. The company also invested in MRP (Materials Requirements Planning) and a number of hiccups occurred during the implementation and introduction process. Eventually, the company was able to manage a partial success.

These IT solutions were able to support the company to cope with the busy routine business activities until the company recently encountered enormous challenges. Firstly, more competitors have entered even contracting markets. Some of these newcomers have even been better equipped with sophisticated IT solutions and are likely to take competitive advantage in terms of responsiveness. Secondly, the customers are becoming more demanding in terms of quality, price, delivery times, and after-sales supports. Finally, the costs of labour and raw materials are no longer a distinctive advantage because they have increased considerably and other competitors are equally enjoying the same benefits anyway.

The external pressure has changed the way in which the operations were internally managed. In the past, although the schedules were busy, operations were generally executed smoothly with very few major hiccups. However, the current situation can be described as "fire-fighting". Some of the problems become apparent. Firstly, the communications between the Mainland manufacturing plants, the Hong Kong headquarter, and customers/suppliers became a major source of a variety of problems. Although managers and engineers from the headquarter visited the manufacturing plants regularly, the effectiveness and efficiency were not impressive because of long journey. Telephone calls, faxes and email messages have been used to compensate the face-to-face communications. The problem of effectiveness and efficiency of these communication methods was even more serious. Very often, data sent through faxes and sometimes

email messages have to be processed again before sensible analyses can be conducted.

Secondly, the new product designs developed at the Hong Kong headquarter tend to have more errors related to downstream business processes. For example, manufacturing difficulties and quality defects exist in many new designs and were not identified promptly. This was because the manufacturing expertise and test labs are located in Mainland China and not readily available and accessible by the Hong Kong development team.

Thirdly, it was evident that the Purchasing and Sales departments spend significantly more time and efforts in clarifying purchase and sales orders with the suppliers and customers respectively. This problem has significantly affected the new product development team because they have to modify their new designs too often to cope with order changes.

Fourthly, there have been increasing complaints from engineers about the increasing number of requests for making changes to the product designs and manufacturing plans. This has not only affected the lead time but also the total costs.

Finally, the product range has increased significantly from a limited few in 1960s to several hundreds at present. Every product is a different product but all the products look similar. The increased product variety has further stretched the increasingly more expensive resources.

The company was determined to solve the problem. During the tide of e-commerce around the turn of the century, the company was naturally advised to look into the potentials of the latest web and Internet solutions. The top management was very open-minded, supportive but skeptical/cautious. As long as IT/e-Business solutions truly deliver their promises in improving the competitive and efficiency significantly, they were prepared to invest in such solutions.

The company was seriously considering getting a suite of sophisticated e-business solutions from a reputable vendor. Consultants from this major vendor were invited to give an overview of its e-business solutions. During the talk, the aggressive promotion by the consultants actually scared the engineers involved in the project. Firstly, the consultants talked about the evolving history of their e-business solutions over one and half decade. This period may be long enough to the IT vendor but short to an IT user. Their systems evolved from early standalone system through networked client-server to fat-client web-based systems. They also indicated that they will launch a fully web-based thin-client system shortly.

Secondly, the consultants pledged that their e-business solutions would contribute to the reengineering and rationalization of the business processes and operations if they were fully implemented. This was in fact imposed by their solutions: whether willing or unwilling, changes must be made to suit the methodologies embedded in the solutions.

Thirdly, the consultants offered intensive training for the company staff members of the project team. The basic training was included in the initial acquisition price of the

suite. However, extra charges would be made to advanced training for features such as customization after the installation and implementation.

Fourthly, the consultants mentioned their joint venture with a service provider for an opportunity for the company to subscribe to their EBS with the Application Service Provider without purchasing the solutions to reduce the acquisition and maintenance costs.

Finally, the consultants proudly announce that they provide a suite of solutions encompass the entire business operations and these solutions can be introduced in different phases according to individual needs.

After the consultants' promotion talk, the company decided not to continue along this direction for the following reasons:

- The solutions themselves have been evolving too fast to follow as an IT user. The fundamental question is can we keep up with the changes made by this vendor? A free upgrading would be attractive. But any fundamental major changes to the user interfaces and underlying methodologies might cause significant problems.
- The business and operation models incorporated in the solutions were not readily compatible with the existing ones of the company and significant changes must be made in order to implement the solutions. This may potentially lead to more fundamental traps, operational chaos, and significant resistance from the engineers and workers.
- The customization of the solutions to suit the company's unique features might take too long and too much specialist skills may be required to customize and maintain the customized systems. Chaos might occur in case of personnel turnovers.
- Training and maintenance costs might be unpredictable and thus unmanageable after a few years with uncertain commitment and benefits.
- The opportunity of subscribing to an Application Service Provider was attractive in some sense. But the above concerns were basically addressed. In addition, this approach introduces a third-party whose commitment is yet a major concern.

For the above reasons, the company decided to abandon the previous approach. Instead, they decided to conduct an exercise of business process reengineering (BPR) for the sake of improving the business operational performance, instead of jumping into EBS directly. Following this "IE (Industrial Engineering) before IT (Information Technology)" approach, Key business processes were identified and then analysed one after another. Problems with each business process were examined and then determined what IT solutions were appropriate. Suitable IT solutions would then be acquired and implemented. The company, however, experienced the following dilemma:

- Very few IT solutions that suit the company's requirements were readily available in the commercial

market. Most such vendors were small IT firms. Long-term customer services become a major concern.

- Those suitable IT solutions were from completely different third-parties. Their interfaces were completely different. They had different user management. After all, they were separate systems.
- If the company really wanted a solution that best suits its requirements, the best approach was to develop it on its own. Several questions arise immediately: Do we have the necessary IT expertise and skills? Can we afford the time and efforts? Is this a commercially viable approach?

The above company and its story is purposefully created to illustrate concerns that typically represent those of many SMEs. The long-term implication is however significant. The DIY approach seems to be most appropriate for SMEs and EBS vendors may have to transform themselves from total EBS vendors to the so-called "Portalets" vendors in the future. The rest of this paper is to explain and justify the belief that the Portalets-based DIY approach is not only a suitable approach to SMEs, but also a commercially viable and technically sound approach.

### **3. Vision towards Digital Enterprises**

#### **3.1. EBS: Electronic Business Solutions**

A web application is defined as any software application that depends on the World Wide Web, or simply web, for its correct execution (Gellersen and Gaedke, 1999). Hence, software systems that are explicitly designed for delivery over the web, for example web sites, and that use the web infrastructure for their execution, are web applications. For example, many information systems that were designed and built prior to the web are now wrapped and made available as web applications through the use of web browsers.

Electronic Business Solutions (EBS) are web and Internet applications or solutions that are used to facilitate the business decision making and executing activities. The imaginary company in the motivating story is interested in gradually introducing a spectrum of web applications throughout the product development and realization process, focusing on topics ranging from market research to the supplies of tools/equipment and raw materials. In other words, one or more EBS are needed for each of its business processes.

#### **3.2. Enterprise Portals**

If a manufacturing enterprise uses only one web application for the purpose of product design, the users access the relevant web pages and components after the successful login session. Because they belong to the same web application, all the web pages are arranged in such a way that they are efficiently and effectively used.

If the enterprise uses multiple web applications, the above method of accessing them can still be used on an

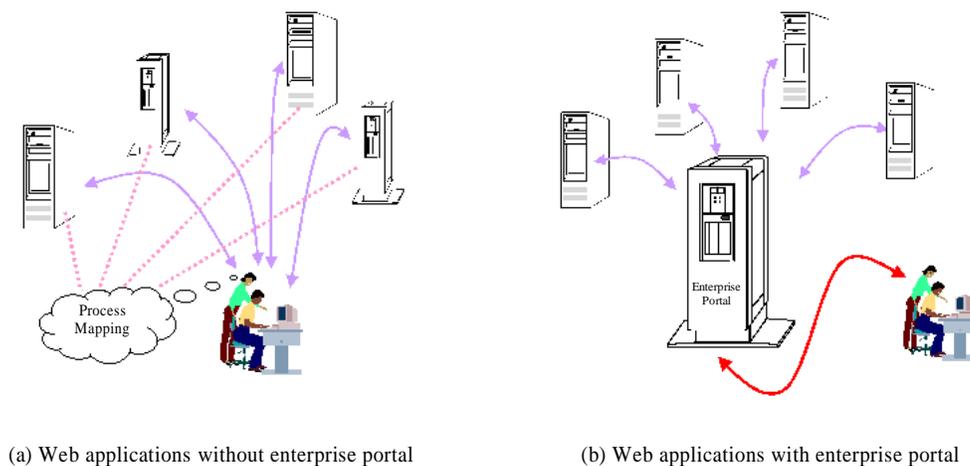
individual basis. That is, the access to each web application is controlled by itself separately. If the number of the multiple web applications is limited to the manageable level, say  $7 \pm 2$ , the users are able to work effectively and efficiently with these web applications. However, if this number increases dramatically and these web applications are left scattered on the Internet without a central hub, it will be very difficult for the designers and team members to locate the appropriate web applications at the right time for the right tasks. This situation is shown in Figure 1(a). The engineers should have an overall picture of the organization's business processes and functions. At the same time, they should also be conscious in the relevant documents, information flow and applications over the Internet. However, the situation will quickly become problematic when the number of information sources increases and the complexity of the business changes dynamically. The situation will be worse by the adoption of standalone and isolated applications, each with different working procedures, different interfaces which are non-self explanatory, and different installation and maintenance requirements.

The concept of enterprise portals is introduced as a central hub for accessing web applications to overcome the above problems, as shown in Figure 1(b). Enterprise portals gather and organise the huge amounts of unconnected data scattered across the enterprise, and then present the information in the forms of window areas, where each containing a view of the enterprise. Enterprise Portals provide a secure, personalized view of the enterprise for each individual user or class of users, based

on job functions, roles or other relevant criteria. An Enterprise Portal integrates disparate sources of information and business logic, and provides a single point of access to the knowledge and processes of the organisation through a simple and intuitive interface to users of the extended enterprise, including customers, employees, suppliers, and business partners alike, with a single point of access to the knowledge and processes of the organization through a simple, intuitive interface. The technicalities of the back-end applications, documents or databases remain in the background and are invisible to users. Using an enterprise portal, these constituencies (customers, partners, employees) can conduct business via the Intranet, Extranet or Internet from wherever and whenever convenient for them.

In the most simplistic sense, an enterprise portal can be simply a web page that has been created to collate the hyperlinks to all the web applications which are basically separate applications with differing functions and user interfaces. A user with multiple responsibilities, each of which requires the access to a web application, still needs to login and access a relevant web application for each responsibility.

Sophisticated enterprise portals are expected to accomplish much more than a web page hyperlinked to web applications. The accesses are usually highly personalized, depending on the roles and responsibilities of the users in the organization. Rapid deployment is achieved while high consistency is maintained. Searching within the portal is facilitated and better teamwork and collaboration is enabled.



**Figure 1** An enterprise portal as a central hub for accessing web applications.

### 3.3. Digital Enterprises

An enterprise is called a “digital enterprise” if its web portal plays an important role in its business activities and decisions. Some digital enterprises conduct their businesses mainly by providing online contents (which are

relatively simple form of web applications) and more sophisticated web applications. Their business processes are entirely accomplished on the Internet.

However, traditional businesses such as manufacturing and even software development extensively employ web applications (and consequently digital

enterprises) across the entire business processes to improve their operational efficiency and quality thus competitiveness. For example, a manufacturer becomes a digital manufacturing enterprise or simply an e-Manufacturing enterprise if it uses the web applications extensively in its business and engineering operations.

Indeed, a digital enterprise has the following characteristics. Firstly, the access to a digital enterprise is logically dimensionless in terms of time and geographical location, although it may be physically distributed (deployed) at different locations. To the user, it is a central web site. The geographical boundaries of the physical enterprise vanish with the emergence of the digital enterprise.

Secondly, a digital enterprise builds up the inter-connections between and among enterprises and intra-connections between and among units within a member enterprise via various levels of access control and authorities. The term "Virtual Enterprise" is often used to describe such a digital enterprise.

Thirdly, the lifecycle activities in the product development and realization processes are no longer arranged sequentially. The corresponding web applications are deployed in parallel across the entire the digital enterprise.

Finally, there is no longer difference between front- and back- offices in the digital enterprise.

#### **4. Approaches to E-Business Solutions**

The motivating story in Section 2 indicated three general approaches to the implementation and adoption of EBS. The first approach is for the enterprises to purchase/license, deploy and maintain the off-the-shelf e-business solutions commercially available in the market. Leading vendors have been developing comprehensive suite of sophisticated e-business solutions that are generally produced for large corporations because of the high costs, built-in business models, oriented towards the western culture, and level of customization and thus training. These are significant difficulties for SMEs (Small and Medium sized Enterprises) to take advantages of the recent developments in the technology.

In order to resolve these problems, efforts have been made by both application solution providers and application service providers to provide online services especially for SMEs. This second ASP approach reduces the cost and minimizes the technical skills required for implementing the technology to an affordable and acceptable level. However, other limitations still exist, prohibiting the widespread use of the technology in SMEs. For example, business models and business processes vary widely from one SME to another. It is extremely difficult to accommodate them into one e-business solution. This can only be achieved through customization which adds significant sophistication to the system and its operation. Advanced training is usually required. In addition to these limitations that are shared by the first approach as well, the ASP approach imposes serious dependency of the

enterprises on the technical and business decisions of the service providers. If a service provider determines to terminate one service, the enterprise users who subscribed for the service will be unable to continue the service, leading to unacceptable interruptions.

The third approach is the "Do It Yourself (DIY)" approach. It is generally perceived that it takes significantly long time and enormous efforts to develop e-business solutions by enterprise users themselves because of technical sophistication and special programming skills even if they are fully familiar with their own business processes and operations. Therefore, it is not usually considered a viable approach to developing an e-business solution for a specific application by an SME.

The research discussed in this paper is mainly concerned with the fourth approach to deal with the above dilemma. This new approach is an extension to the third "Do It Yourself (DIY)" approach to e-business solutions. This DIY approach is however enhanced by the concept of "portalets" that emerge from the software product line management. This portalet-based DIY approach is expected to reduce the total adoption cost dramatically by at least 50~70% to a level affordable by SMEs. Such reduction is achieved by eliminating costs involved in the comparison and acquisition of the e-business solutions while keeping the development time and efforts to a level equivalent to those involved in the training and customization of commercial e-business solutions. In addition to the cost reductions, the DIY approach allows the SMEs to incorporate their own business models and business operations into the e-business solutions, instead of being rigidly imposed and prescribed by commercial systems. By so doing, SMEs are able to truly exploit the technology to support their daily decisions and operations thus really improve their competitiveness.

#### **5. Portalets-Based DIY Approach**

Let us now focus on examining its feasibility from the following aspects:

- Nature of the Internet and web technology
- Maturity of the Internet and web technology
- Readiness of technological developments
- Efforts of business process reengineering
- Awareness and enthusiasm of MIS
- Software product line / platform management

##### **5.1. Nature of Internet and Web Applications**

An EBS basically follows the so-called 3-tiered architecture. It normally includes three parts: the application client, server and database. One of the advantages of this architecture is its modularity for changing one component without or with little impacts on the other two. For example, the enterprise business logics are usually captured in the middleware server components. The client components can be added according to individual user requirements. The business data and the business logics are relatively independent of each other.

## 5.2. Technology Maturity

The Information Infrastructure Technology, both hardware and software, are evolving very rapidly. However, several aspects have reached a mature stage that justifies the DIY approach. For example, relational databases are now more or less standardized with a few limited dialects. SQL (Structured Query Language) is used in conjunction with JavaScript and/or VBScript on the server side to deal with the data between the database and the clients. These scripting methods are also relatively standard, widely taught with other standard web programming skills. Any graduates are expected to have reasonable understanding and skills in these aspects after completing courses like Information Technology, Information Systems, Computing and Programming, etc.

On the hardware and system side, setting up a web server and web site has been made as easy as creating a file for word processing by following simple instructions. This is expected to be improved even further in the near future.

## 5.3. Efforts of business process reengineering

Companies have been increasingly engaged in rationalizing and streamlining their business processes. Through these efforts, the workflow and information within the organizations are better structured to an extent that is difficult to change again to suit the requirement of a particular IT solution but ready for specifying a custom system that suits itself most.

- Simplify the business operations
- Streamline the business process
- Rationalize the flow of work
- Reveal the potential bottleneck issues
- Outline the fundamental logic and method

## 5.4. Software Product Line / Family

Advanced theories and methodologies for designing manufactured products have been a major area for research. One of such approaches is the so-called Platform Product Development (Robertson and Ulrich 1998). Similar approaches are emerging for designing, developing, deploying and maintaining software products. For example, Parnas (1976) and Meyer and Lehnerd (1997, Last few chapters) are dedicated to Software Product Line and Software Platform approaches respectively. The greater reusability and modularity will not only speed up the development process but also improve the interchangeability and exchangeability among EBS with the same enterprise.

## 5.5 Insights from Past Case Studies

Over the last 5 years, the first author has led a group of researchers at the University of Hong Kong on a variety of research projects involved in developing prototype web applications in product design and manufacturing with the financial supports from Hong Kong Government Research Grants Council and the University of Hong Kong Research Committee. Recent developments have been documented in Huang and Mak (2002). Some examples are listed:

- Engineering change management

- FMEA (Failure Mode and Effect Analysis)
- QFD (Quality Function Deployment)
- Design for X
- Collaborative Product Design Review
- Early supplier involvement in new product development
- Morphological chart analysis for concept generation and evaluation
- Market testing with conjoint analysis

Our direct experience from these projects shows that the Internet and web technology lend itself a strength of rapid development and deployment of applications components if certain templates are provided for key issues such as database connection, user interface formatting, etc. The time and efforts of developing a “new” application by this ‘Do It Yourself’ approach is no more than that involved in customizing a comprehensive commercial suite and participating in training courses. Customizing a system requires in-depth knowledge about the system, and therefore requiring intensive training. Our experience shows that 1-3 months of efforts are generally sufficient for two persons to develop one simple EBS, assuming that they have the necessary skills and background knowledge about the application. The “necessary programming skills” that we are referring here are not specialist skills, but common programming techniques such as SQL, Java scripts, and HTML scripts. These have been widely taught in undergraduate courses of not only computer and software engineering but also other engineering disciplines such as industrial engineering. If the source codes of some templates are available, this time and effort level can be further reduced below 2 months. This is the level that is usually required to learn how to use and customize a commercial e-business solution. By so doing, the high acquisition costs of the commercial systems are avoided, while company-specific business and operation models are easily accommodated.

## 6. DIY Portalets as Product Family Platform

“Applets” and “Servlets” are well-known Java constructs for building up client and server components of web applications, respectively. ActiveX components and Enterprise Java Beans (EJB) are two more recent concepts of competition. One of their main purposes is to standardize the techniques and constructs to facilitate the design, development and deployment of the web solution components at different levels (tiers).

### 6.1. Portalets

By following the similar conventions such as Applets and Servlets, the term “Portalets” is introduced to represent powerful constructs for developing enterprise portals. This introduction is necessary when more and more web applications are put into practice to support business operations, leading to the emergence of digital enterprise. The scope of this paper is limited to the manufacturing context, especially product design and manufacture.

There are at least three approaches to building enterprise portals and their features are summarized in Table 3. In a recent enterprise portal market study, Meta Group found that 75% of enterprise portal development efforts were still being accomplished using labor-intensive traditional web development environments. Their research concluded that companies should use portal frameworks or portalets, rather than conventional web tools to build their enterprise portals.

Portalets themselves are web applications for managing other domain-specific web applications. As a matter of fact, some utility web applications such as calendar, email, online chatting, bulletin board, whiteboard, etc. are delivered as constituent components of some commercial enterprise portalets.

Enterprise portalets range from simple Intranet indexing and search tools to enterprise-level database-driven information storage and retrieval products. Table 3 summarizes, without prejudice or preference, some of the typical enterprise portalets commercially available on the market. Although they offer competing features and unique facilities, they serve the similar purpose of facilitating the deployment of web applications to form enterprise portals. Figure 5 shows the architecture of the appssolut Enterprise Portal Suite (<http://www.appssolut.com>).

An enterprise portalet differs from general-purpose website development environments such as Microsoft Frontpage while sharing numerous common functions. A website development environment is generally considered as an environment for developing and deploying individual web applications ranging from simple HTML contents to web pages with sophisticated computational components embedded or attached.

In contrast, an enterprise portalet provides an environment for deploying various individual web applications into a central website called an enterprise portal. There is no doubt that environments like MS Frontpage have been used for this purpose in practice. However, this approach is unlikely to meet the requirements set out for many commercial enterprise portalets (see for example White Papers of portalets listed in Table 2).

### 6.2. Portalet Architecture

Because portalets themselves are web applications, they also share the 3-tiered architecture, as shown in Figure 2. This point is the major difference between the portalets and applets/servlets (ActiveX components and Enterprise Java Beans as well). Therefore, a portalet may include an applet at the client tier, a servlet at the web server tier, and of course a database at the data tier. Some of the alternative combinations are given in Table 1.

Another point worth pointing out is that different portalets can be obtained through different configurations of the same set of components at the 3 tiers. For example, "TreeTable portalet 1" is formed by combining the "HTML Table" client with the Server-side scripting and SQL recordset. "TreeTable portalet 2" is formed by

combining the "TreeTable Java Applet" client with the Server-side scripting and XML data.

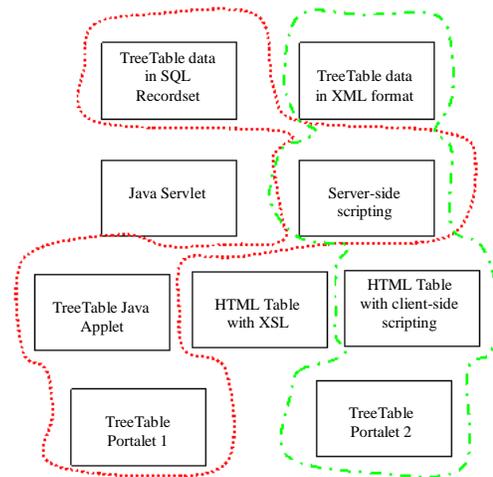


Figure 2 3-Tiered Portalet architecture.

Table 1 Alternative combinations of portalets

	Client Tier	Server Tier	Data Tier
1	Applet	Servlet	RDBM SQL
2	Applet	Server-side scripts	
3	HTML with scripts	Servlet	
4	HTML with scripts	Server-side scripts	

### 6.3. Portalets-Based EBS

The concepts of ActiveX components and Java Applets/Servlets/Beans have been devised by various IT vendors as basic constructs for building up web applications. The aim is to improve the reusability and rapid development/deployment. However, the technical complexity is still high and often not suitable for the DIY approach because the level of technical skills required is high. For this reason, these components should usually be designed and developed by highly skilled IT professionals and programmers. After they are purposefully configured into portalets, it becomes straightforward to design (configure) and develop a new EBS. For example, Figure 3 shows how to use the same set of portalets (general-purpose) to develop two completely different web applications, one for presenting the Bills of Materials (BOM) in product development in Figure 3 (a), and the other for archiving Design Objects (usually documents) submitted for review. Because they are based on the same portalets, the configuration and customization are extremely easy to accomplish.

Header Portalet
Pull-Down Menu Portalet
Toolbar Portalet
TreeTable data in SQL Recordset
StatusBar Portalet

**Figure 3 (a)** Web solution for managing the Bills of Materials (BOM) in product development.

Header Portalet	
Pull-Down Menu Portalet	
TreeTable data in SQL Recordset	Toolbar Portalet
StatusBar Portalet	

**Figure 3 (b)** Web solution for managing the Design Review in product development

#### 6.4. Towards EBS Family Portalets Platform

Because of our primary interests in web-based collaborative product design and manufacturing, a set of portalets specialized in Collaborative Product Commerce (CPC) will be developed to demonstrate our proposed portalet-based DIY approach to EBS, in addition to some general-purpose portalets. These portalets become common features shared by all the resulting EBS. This will lead us to develop further along the direction of Software Product Line or Family management.

#### 7. “TreeTable” Portalet Example

The lower part of Figure 4 shows an example of a TreeTable. The first column is an indented tree structure and the rest is actually a table. The tree branches can be extended to show and collapsed to hide details. Therefore, only the useful information is displayed at a time while giving the necessary overview. This combination of a tree and a table has been widely used in building the user interfaces of e-business solutions because many items of the enterprise information including engineering, business

and market information are logically represented in this treetable format. It has also been widely used in most of our own prototype systems mentioned in the preceding section. As a result, TreeTable should be constructed as a “portalet” in our DIY e-business framework.

As shown in Figure 4, this TreeTable portalet includes three components that are ready for inclusion in the components corresponding to the 3 tiers of the web application. Source codes have been omitted from the paper because of limited space of 10 pages allowed for the proceedings of this conference.

#### 7.1. Database Structure for “TreeTable”

The top of Figure 4 shows database tables used to construct a TreeTable for representing the Bills of Materials (BOM). The “Parts” Table is used to store the items of the BOM tree. The hierarchical relationship between the items is of the “many to many” type. The “BomStructure” Table is used to store these relationships. The “ParentID” and “ChildID” correspond to the two items in the “Parts” table, indicating the item with “ChildID” is a branch of the item with “ParentID”. The 3<sup>rd</sup> table, actually a group of tables, provides additional information for describing the BOM items and their relationships.

The customization at the database level (tier) becomes very simple exercise of copying and then renaming the “Parts” and “BomStructure” tables to form new tables. There is even no need to change the naming scheme of the fields of the new tables for the “Tree” area. For the Table area of the TreeTable, additional data tables can be easily created to suit specific applications.

#### 7.2. “TreeTable” Middleware Data Structure

The TreeTable portalet middleware that is used by the application server includes a few lines of scripts (either JavaScript or VBScript) to be embedded in the application server. First of all, the database must be connected. In Microsoft Active Server Pages, a few lines of short codes are needed to connect the application server to the database and then remember the connection as a session variable for future references. These connection codes are extremely simple and modular, independent of any other codes. Therefore, customization is straightforward.

The TreeTable data are retrieved using the SQL (Structured Query Language) together with the Java/VB scripts. The retrieved data can be represented in the native form of recordset or resultset of the particular Relational Database Management (RDBM) system.

Once again, the customization of the SQL string is straightforward. If the naming scheme for the fields are not changed, only the names of the tables need to be modified in the SQL string, and no other changes are necessary.

Alternatively, the retrieved data can be represented in the XML data structure, either directly from SQL if it support such conversion or through an XSL template to convert the SQL recordset into hierarchical XML data structure. XSL templates normally need not be changed for different applications.

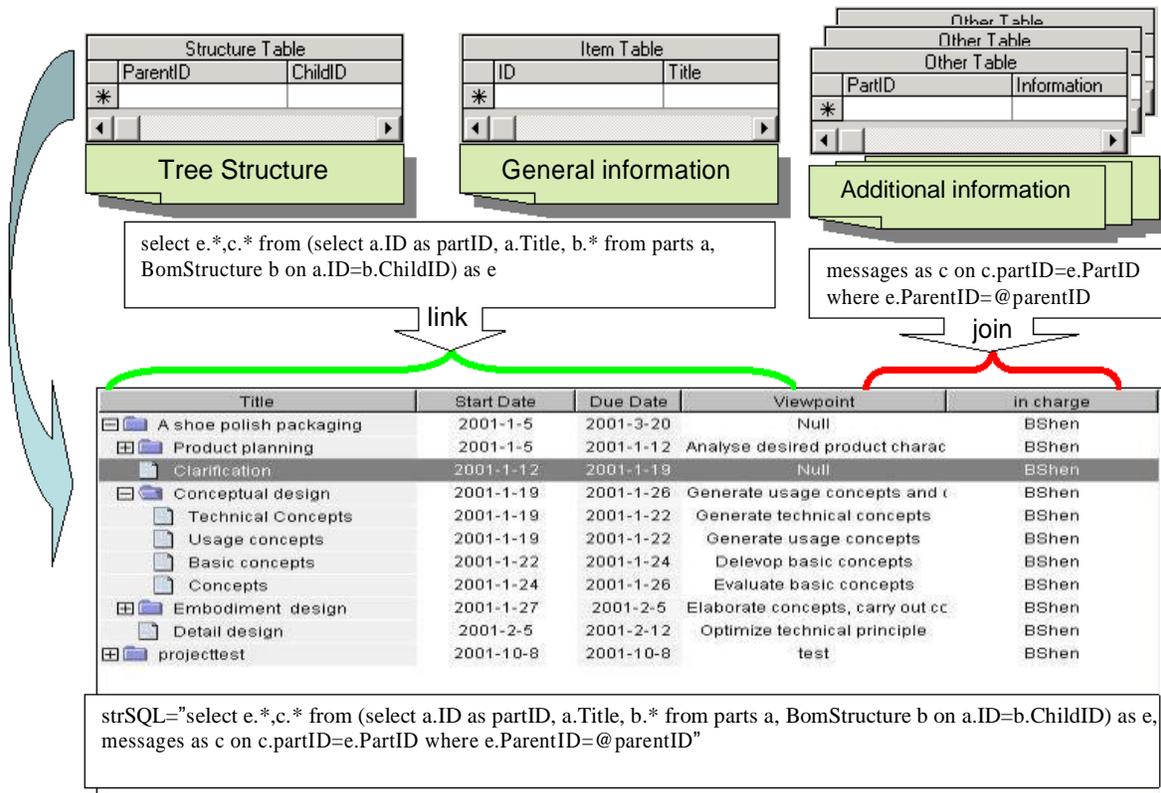


Figure 4 TreeTable Portalet and its components at the 3 tiers.

### 7.3. "TreeTable" Clients

Several methods exist for building TreeTable clients:

- Using a commercial Java Applet with SQL recordset
- Using standard HTML table with SQL recordset
- Using standard HTML table with XML without XSL
- Using standard HTML table with XML and XSL

#### 7.3.1. "TreeTable" Java Applet with SQL Recordset

One method is to take advantage of ready-made TreeTable Java Applet, several versions of which are commercially available on the market. In MS Frontpage, server-side scripts are used to populate the data in the TreeTable Applet. The populating action takes place on the server side while the contents of the TreeTable are displayed on the client side.

The server-side codes include a few sections to greatly improve their modularity to facilitate the customization. For example, an independent procedure is prepared for populating the column headings of the TreeTable from the names of the columns of the recordset. Another independent procedure is prepared for populating the menu items for the right-click events of mouse buttons over the TreeTable items (rows). Finally, a procedure is developed for building up the tree branches and their associated information items.

The above three sub-procedures are used to form an overall procedure for building up the TreeTable. It takes an SQL as its input variable. Therefore, for different applications, it is only necessary to change the SQL string without changing the TreeTable procedure at all.

#### 7.3.2. TreeTable with HTML Table from XML and XSL

If the retrieved data are represented in a nested XML format where nesting indicates the hierarchy in the TreeTable, then there are two ways of populating the XML formatted data into a HTML table. One is to use the script and the other is to use XSL. The latter is demonstrated here for its better modularity. The XSL template is designed and developed such that it converts any nested XML data into a TreeTable regardless of their contents. As a result, only the SQL string is needed for different applications and no further changes are necessary.

## 8. Conclusions

This paper has argued for the necessity and demonstrated the feasibility of developing e-business solutions by the SME manufacturing companies. This DIY approach is only practically viable with the support of the concept of "portalets". Portalets are built upon standard web and Internet technologies. They are basic constructs commonly used in web applications. They are highly modular,

implying that no or little customization is required to adapt to a particular application. Portalets are logically configured to form what is called a “platform” of a software product lines/family. As a result, the portalet-based DIY approach to e-business solutions offers several advantages:

- The requirements for specialist IT skills are dramatically reduced to a level attainable by engineering graduates with certain on-site training.
- Developing and maintaining web applications (web pages) become as simple and easy as create, revise and maintain a word document.
- The time and efforts of developing e-business solutions are dramatically reduced to a level competitive to out-sourcing commercial e-business solutions.
- DIY e-business solutions are able to accommodate the unique business models and operation models of a particular company demanding minimum changes to the current good practice.
- The upgrading and extensions can be made freely without any external constraints at any time whenever necessary.

Further work will be conducted to substantiate the portalet-based DIY approach to e-business solutions in three directions. One is to create a number of widely used portalets such as TreeTable, Menu, Table, Charts, FillForm, etc. Another direction is to create a framework for configuring portalets within a web application according to certain requirements. Finally, case studies will be conducted to demonstrate how the proposed approach can be used to develop CPC (Collaborative Product Commerce solutions).

The impact of the portalet-based DIY e-business approach is enormous and fundamental. One has to change the traditional perception that e-business solutions require mythical specialist skills to develop and therefore have to be acquired (purchased or licensed) at high cost with intensive training. The technology has now evolved to a stage and provided an opportunity that one is now able to take full advantage to maximize one’s competitiveness in one’s own way and pace.

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## References

1. Anton, A.I., Liang, E. (1996) “A Web-based requirement analysis tool”, In: Proceedings of WET ICE’96, 238-243
2. Faulkner, P D (1997) "Statistical process control of test results via the Internet", In: Proceedings of

- National Electronic Packaging & Production Conference, 1997, 1159-1165
3. <http://www.aboutportals.com/technology/>
4. [http://www.portalwave.com/portal\\_wave/application.html](http://www.portalwave.com/portal_wave/application.html)
5. Huang, G.Q., and Mak, K.L., 2002 (2003), Internet Applications in Product Design and Manufacturing, Springer-Verlag (In press).
6. Kalyanapasupathy, V., Lin, E., Minis, I. (1997) "Group Technology code generation over the Internet", <http://www.isr.umd.edu/Labs/CIM/profiles/lin/docs/gt/>
7. Meyer, Marc H. and Alvin P. Lehnerd (1997). *The Power of Product Platforms*. New York, The Free Press.
8. Miller, J.A., Palaniswami, D., Sheth, A.P., Kochut, K.J., Singh, H. (1997) "WebWork: METEOR2's Web-based workflow management system", *Journal of Intelligent Information Systems*, Vol. 10, 185-215.
9. Muller, P.C., de Poorter, R., de Jong, J., van Engelen, J.M.L. (1996) "Using the Internet as a communication infrastructure for lead user involvement in the new product development process", In: Proceedings of WET ICE'96, 220-225
10. Parnas, D.L. On the Design and Development of Program Families. *IEEE Transactions on Software Engineering*, SE-2:1-9, March 1976.
11. Pham, D.T. (1998) <http://intell-lab.engi.cf.ac.uk/manufacturing/ipm/ipm.html>
12. Robertson, D. and Ulrich, K., 1998, "Planning for Product Platforms" *MIT Sloan Management Review*, Summer 1998, Vol. 39, No. 4, 19-31.
13. Taligent. *The Power of Frameworks*. Addison-Wesley Publishing Company, Reading, MA. 1995.
14. Weiss., D., Commonality Analysis: A Systematic Process for Defining Families. In Proceedings of the *Second International Workshop on Development and Evolution of Software Architectures for Product Families*. (February 1998).
15. Ariba from [www.ariba.com](http://www.ariba.com)
16. Baan e-business suite from [www.Baan.com](http://www.Baan.com)
17. CommerceOne from [www.commerceone.com](http://www.commerceone.com)
18. eSolution product suite from [www.aspectdv.com](http://www.aspectdv.com)
19. <http://www.appsolut.com/Default.htm/>
20. i2 from [www.i2.com](http://www.i2.com)
21. Oracle e-business suite from [www.Oracle.com](http://www.Oracle.com)
22. SAP e-business suite from [www.SAP.com](http://www.SAP.com)
23. Windchill from [www.PTC.com](http://www.PTC.com)

# A Loss-Free Micropayment Protocol for Multimedia Services

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## Abstract

A micropayment scheme is proposed to enable transactions of different denominations and to eliminate possibilities that either the vendor or the user in a payment system misbehaves to get illegal profit. The proposed offers a solution while keeping transactions efficient.

## 1. Introduction

The Internet is, nowadays, a source for information seekers to have a variety of services such as stock quotes, news reports, video streams, etc. These multimedia services in essence may include text, audio, and/or video information that have different values for information providers. As the cost of each kind of service differs from one another, every service may need different numbers of tokens if single-denomination tokens, such as payword, the payment token of PayWord [1] protocol, is chosen as the information seeker's payment tool. PayWord uses a one-way hash function to produce successive tokens, and it is frequently referred to among other schemes in literature, such as Millicent [2], iKP [3], and MicroMint [1]. With the irreversible characteristic of one-way hash function, this scheme prohibits receivers of a payword token from guessing subsequent tokens while keeping the process of transactions efficient. If a service costs more than a single token, the nature of payword token leaves the potential risk to the token holder that he or she may lose some or all tokens given to the service provider without receiving anything. When the span of Internet services consistently grows, the flexibility of payment tools should be noticed.

In addition to flexibility, the issue of fairness is generally important for most on-line payments. In the environment of micropayment transactions, this issue is usually left intact. When a payword token is passed to the vendor, it is the user's potential loss that the vendor might redeem that token without sending the target information good to the user. Namely, the vendor may gain improper advantage over the user in PayWord protocol if he or she accumulates and redeems tokens without offering services.

We hereby propose a solution to prevent misconducts of both the user and the vendor while retaining its payment flexibility in transaction value. It is particularly suitable for web sites providing multimedia services that have payments of different values.

## 2. Literature Review

In this paper, discussion and analysis are focused on PayWord and other protocols based on the successive release of elements in a chain of cryptographic hash values. There are three participants in PayWord: the user  $U$ , the vendor  $V$  and the broker  $B$ . Each user has to register with information such as the broker's name, the user's name and the user's public key, with at least one broker, which offers a PayWord certificate. This relationship is represented by a PayWord certificate signed and issued by the broker, which binds the broker's name, the user's name and the user's public key together.

Before  $U$  requests a service from  $V$ , a fresh chain of hash values  $w_n, w_{n-1}, \dots, w_1, w_0$  is generated by randomly picking  $w_i$  in formula (1).

$$w_{i-1} = h(w_i), \text{ for } i = n, n-1, \dots, 1. \quad (1)$$

Notably,  $h$  is a one-way hash function, which is publicly known and cryptographically strong. Furthermore,  $w_0$  represents a root of the hash chain, and is delivered to  $V$  at the beginning of a service session. Root  $w_0$  authorizes  $B$  to pay  $V$  for any of the tokens in this chain that  $V$  redeems thereafter.

$U$ 's  $i$ th micropayment to  $V$  consists of the pair  $(w_i, i)$ . The validity of this token can be verified by  $V$  using  $w_{i-1}$  which is known from the previous payment or from the commitment in case of  $i = 1$ .

If no dispute occurs,  $V$  presents  $w_0$  and the final token received to  $B$ .  $B$  verifies their legitimacy and if successful, pays  $V$  the amount that corresponds to the tokens and charges the same amount to  $U$ 's account. When  $V$  misbehaves,  $U$  will lose at least the last token already sent to  $V$ . Even though the value of a payword token is not high enough to cause serious loss for the user, a persistently cheating vendor can collect a substantial amount of money by sending an unexpected service or nothing at all.

## 3. Revised scheme

The proposed micropayment scheme is a variation of PayWord, and it is also inspired by Asokan *et al.*'s proposal, an approach that achieves a complete and fair exchange [6]. The main idea of our scheme is to make a valid token a combination of two hash values from two independent hash chains. These two hash values can be regarded as two half-tokens. The first is forwarded to the vendor before service provision and the second is not sent until the service is provided. That is, unless the

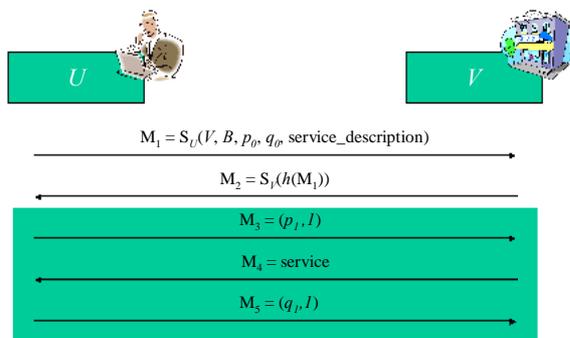
vendor offers the requested service, a complete token cannot be collected and redeemed. This feature secures the user from the vendor's malicious redemption without offering the requested service.

Before transactions begin,  $U$  must register with  $B$  and obtain a signed certificate. Information recorded on this certificate includes  $U$ 's id,  $B$ 's id, and  $U$ 's public key. Thus,  $U$  generates fresh hash values;  $p_n$ , and  $q_n$  are randomly chosen, and  $n$  is decided based on his or her own need. Via the same secure one-way hash function  $h(\cdot)$ ,  $U$  computes two hash chains  $p_n, p_{n-1}, \dots, p_0$  and  $q_n, q_{n-1}, \dots, q_0$  as shown in formulae (2) and (3).

$$p_{i-1} = h(p_i), i = n, n-1, \dots, 1. \quad (2)$$

$$q_{i-1} = h(q_i), i = n, n-1, \dots, 1. \quad (3)$$

The roots of the chains are  $p_0$  and  $q_0$ , and  $U$  sends these values to  $V$  at the beginning of the service session. Thus, every legitimate token is composed of two hash values; i.e., the token used in the  $i$ th transaction is  $(p_i, q, i)$ .



**Fig. 1. The initialization steps and the first transaction of the proposed protocol**

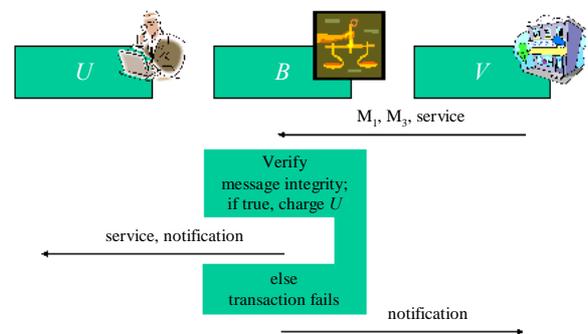
$U$  begins a new transaction session by passing  $p_0, q, n$ , user certificate, as well as a general description of the requested service to  $V$  as a session commitment. A transaction session may have one or more transactions that  $U$  pays by the same token chain.  $V$  uses this commitment for token verification when tokens from  $U$  have been received. Then  $V$  signs and returns this message as his service provision commitment to offer the requested service. The initialization procedure of a transaction session is completed when the service provision commitment ( $M_2$  in Figure 1) is transmitted to  $U$ . This procedure is shown as the first two messages transmitted in Figure 1.

When a transaction session begins,  $U$  sends  $(p_i, i)$  to  $V$  as the first half-token of the  $i$ th micropayment. As a half-token,  $p_i$  also represents  $U$ 's payment commitment for that transaction.  $V$  validates  $p$  by comparing  $p$  and the result of hashing  $p_i$   $i$  times. The root  $p_0$  is retrieved from  $U$ 's session commitment. If the validity of  $p_i$  is confirmed,  $V$  may transmit the requested service to  $U$ .  $U$  must provide the second half-token  $(q_i, i)$  after receiving

the service. The vendor examines this half-token in the same manner exactly as the first half was.

In an ideal case,  $V$  sends  $B$  the session commitment of  $U$  and the last token collected, requesting payment redemption.  $B$  pays  $V$  and charges  $U$  the value of  $i$  tokens.

Because the proposed enables payments that cost multiple tokens, the issue of dispute handling should be more carefully examined. If disputes occur between  $U$  and  $V$ , they can be either one of the following two cases. If  $V$  refuses to offer the service  $U$  requested after receiving the first half-token  $(p_i, i)$ ,  $U$  has no loss as long as  $U$  does not send  $(q_i, i)$ . Even  $V$  receives other first half-tokens such as  $(p_{i+1}, i+1)$  for successive transactions, he or she can only verify the validity of first half-tokens. Without receiving requested services,  $U$  will not send the second half-tokens. In this case,  $V$  cannot get any illegal profit by redeeming only half-tokens.



**Fig. 2. Dispute handling**

The other case is shown in Figure 2, which occurs when  $U$  refuses to pay the second half-token after receiving the requested service.  $V$  in this case may show  $B$  the information collected from  $U$ 's session and payment commitments previously received. The target service of this transaction also has to be sent to  $B$ . Being a trusted third party,  $B$  justifies the dispute based on the information offered by  $V$ . If it is  $U$ 's malicious behavior to refuse to pay,  $B$  will pay  $V$  from  $U$ 's registered account directly, and pass the target service to  $U$ . Hence neither  $U$  nor  $V$  benefits from misbehaving in this case.

If true fairness is not absolutely necessary or the dispute handling efficiency is a serious concern, the idea proposed by Buttyán can also be applied in this proposed scheme.  $U$  is charged once the first half-token is sent; regardless of whether the second half-token is paid for or not. When  $V$  attempts to redeem with only a half-token, he or she will not be given the value of the incomplete token. Revenues from such disputes are donated to charity.

#### 4. Analysis

The proposed scheme makes the user free from possible losses caused by payments that cost more than

one token. And it is applicable to most practical Internet micropayment environment. When a user  $U$  intends to receive some information services from an on-line news web site  $V$ , for example, objects including text files, voice streams or even video clips satisfying the keyword are available. If these types of information objects are charged at different rates, the user of PayWord or other related extensions has to prepare token chains representing different denominations, otherwise he or she will have possible loss if paying multiple tokens of the same hash chain to a misbehaved web site. The user therefore has to prepare tokens of all denominations he or she needs before the transaction session begins. In case the user requests for a video clip that costs six tokens, either this user generates a new hash chain and tells the vendor that each token of this new chain represents exactly six units, or he has possible loss when giving all six tokens from the same hash chain. In other words, if malicious  $V$  is given  $w_6$  in PayWord, all six tokens from  $w_1$  to  $w_6$  can be verified and redeemed directly. Similarly, if  $V$  is given  $w_6$  in Buttyán's scheme, three tokens  $(w_1, w_2, 1)$ ,  $(w_3, w_4, 2)$  and  $(w_5, w_6, 3)$  will be regarded as valid and redeemed. Another way to avoid such loss is to make every payment a combination of tokens from chains that represent different denominations. Both situations would not be convenient enough for the web surfers and would cause restriction to micropayment applications.

In addition, the PayWord user might lose all  $i$  tokens if he or she pays  $w$  for some service that costs  $i$  tokens. Similar situations occur in other PayWord-like micropayment schemes. In this proposed scheme, the two half-tokens,  $(p_i, i)$  and  $(q_i, i)$ , are chosen from two independent hash chains. Hence even a service costs  $i$  tokens,  $V$  can only verify the received  $p_i$ . There is no means to compute a complete token unless  $U$  reveals the second half-token  $q$ . Taking the situation stated in the previous paragraph as an example, when  $U$  has paid  $p_i$  and the requested news report has yet to be received,  $U$  is free from any loss as long as he or she does not send  $q$  to  $V$ . It is easy for the on-line news web site to verify  $p_i$  via  $p_0$ , but mathematically difficult to compute or guess  $q_i$ . Hence, the web site  $V$  collects a full token  $(p_i, q)$  only if  $U$  receives the report and sends  $q$ .

In terms of efficiency, our scheme is roughly the same as Buttyán's. PayWord, Buttyán and the proposed all have the same number of public key cryptographic operations, including digital signature generation and verification. Although the proposed scheme requires twice the number of hash computation as PayWord does, it is still affordable due to the computation efficiency of hash function. Regarding transmission payload, this protocol sends 2 hash values for every consecutive transaction step, which is 1 hash value more than Buttyán's scheme. It would not cause serious network loading considering the size of a single hash value.

In comparison to Buttyán's and other PayWord-like schemes, the proposed offers better protection for both the user and the vendor. PayWord cannot justify the

malicious denial of service when  $V$  redeems the received paywords.  $U$  can only minimize his or her loss by refusing to make further transactions with  $V$  passively, after losing some tokens for incomplete services. In other words, by accumulating tokens from numerous users, the malicious vendor still gets a fortune of illegal profit. As to Buttyán's protocol, although neither  $U$  nor  $V$  takes improper advantage over the other party,  $V$  still bears potential losses when  $U$  refuses to pay after receiving the requested service.  $U$  in this scenario will be charged, but the revenue will be donated to charity instead of distributing to  $V$ . Our scheme does not cause such losses. As long as the second half-tokens are kept by  $U$ ,  $V$  cannot make any illegal profit by redeeming the incomplete first half-tokens. If  $U$  refuses to pay the second half-token after receiving the target service,  $B$  will be the trusted third party to justify whether  $V$  should be paid. Hence the proposed protocol causes no losses in the scenarios mentioned above.

## 5. Conclusion

A variation of the PayWord protocol was proposed to enable payments of different values without much loss in efficiency while the rights of both the user and the vendor are well protected. It solves the problem to pay varieties of multimedia services of different costs. Comparing to PayWord, it although requires twice as many on-line hash computations by the vendor, the complexity of hash computation should not be a real burden. Thus the advantages of this scheme lead micropayment to greater flexibility in real-world applications.

## References

1. R. Rivest and A. Shamir, *PayWord and MicroMint: Two simple micro-payment schemes*, Technical report, MIT Laboratory for Computer Science, 1996.
2. S. Glassman, M. Manasse, M. Abadi, P. Gauthier, and P. Sobalvarro, 'The Millicent protocol for inexpensive electronic commerce', the Proceedings of the 4th International World Wide Web Conference, December 1995, pp. 603~618.
3. R. Hauser, M. Steiner, and M. Waidner, *Micro-payments based on iKP*, Technical report RZ 2791, IBM research, February 1996.
4. L. Buttyán, 'Removing the Financial Incentive to Cheat in Micropayment Schemes', *Electronic Letters*, January 2000, Vol. 36, No. 2, pp. 132~133.
5. L. Buttyán and N.B. Salem, 'A Payment Scheme for Broadcast Multimedia Streams', the Proceedings of the 6th IEEE Symposium on Computers and Communications, 2001, pp. 668~673.
6. N. Asokan, M. Schunter, and M. Waidner, 'Optimistic Protocols for Fair Exchange', the Proceedings of the 4th ACM Conference on Computer and Communications Security, 1997.

# Planning and Decision-Making Process of a Strategic IT Investment: A Case of a Web Content Management System in a Financial Organization

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## Abstract

A modern business organization is increasingly dependent on smooth and reliable flows of data and information, both laterally and vertically, and both within and across its boundaries. Therefore, managing data should be viewed as an element of a fundamental corporate process. Information systems investments aim at enabling and supporting these processes. Investment decisions, again, originate from organizational strategies that need to be aligned with IT strategies, for systems to enable and support business processes. The topic of our enquiry is the planning and decision-making of those systems that qualify as strategic.

We have created an extended framework to cover strategic, tactical and operational levels of planning and decision-making, also focusing on related control, communication, benefits management, and follow-up activities. Our research approach is a single case study method using a multinational financial services company. The investment is a Web Content Management (WCM) system that the company wishes to deploy in a unified, centralized manner throughout the business and geographical areas with the intention of reaping synergy effects. In the paper we enumerate our observations on the strategic planning process, decision-making, control and communication.

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## 1. Introduction

A modern business organization is increasingly dependent on smooth and reliable flows of data and information, both laterally and vertically, and both within and across its boundaries. (The term “data” is used interchangeably with information.) Data is also increasingly considered as a corporate resource, having in

certain contexts a critical effect on day-to-day operations. Therefore, creation, accrual, manipulation, storage, distribution and use of data can, and should be viewed as elements of a fundamental corporate process. The constantly growing share of investments allocated to the area of information systems is evident from the constant growth of supplier industries, be they hardware, software or data communication vendors or consultants.

Any single benefit aimed at, may alone represent the sole purpose of an information systems investment. Alternatively, organizations may seek benefits in various combinations. An all-encompassing combination, i.e. a set of desired systems falls under the concept of strategic information systems plan (“SISP”) [1]. The systems are commonly categorized as compulsory – like ones enforced by a public authority, financial benefit accruing – such as revenue increasing or cost reducing, new business enablers – such as new product or service, and strategic – usually overarching systems linked to the organization’s strategic goal setting. Systems development may take place singly or as part of a major program. Currently, especially strategic systems investments are very often a part of a larger strategic development program. They allow for streamlining operations and business processes both inside an organization, and between an organization and its partners in business. These development programs are guided by the decisions made upon the business and IT strategies on corporate level. The business and IT strategies are intended to be in line with each other, i.e., aligned. Our conceptual framework for strategic business and IT planning is illustrated in Figure 1.

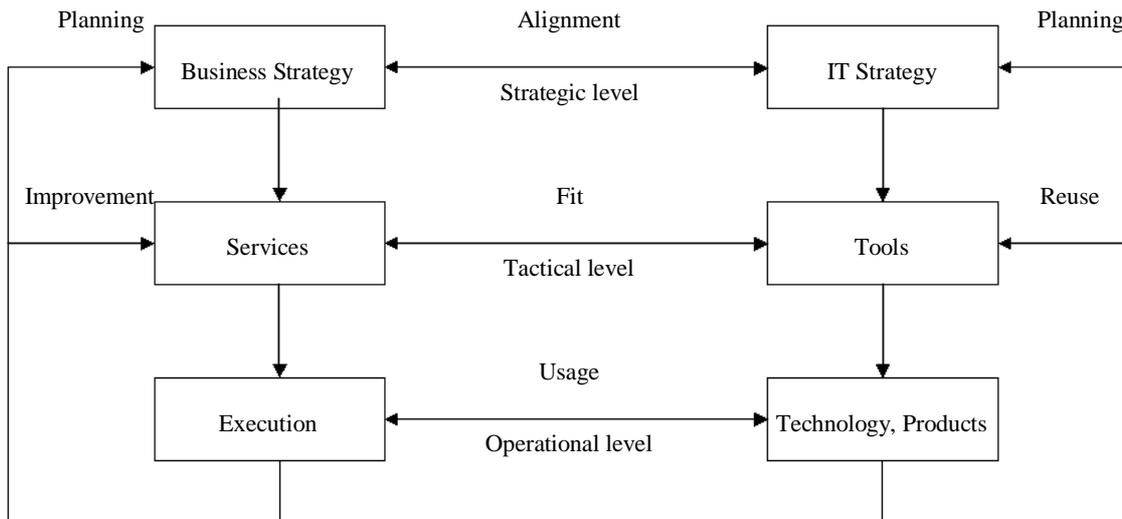


Figure 1 Strategic Planning Framework

The business strategy guides the development and implementation of services to customers, as well as the development and implementation of the internal business processes in an organization. The IT strategy guides the acquisition, implementation and service delivery of IT tools to support the organizational functions. The business and IT functions need to be aligned on the strategic level. Additionally, a fit is needed on the tactical level of business services and IT tools [2] [5]. Furthermore, the alignment and fit is actually tested on the operational level during the use process of information technology and individual IT products.

The turbulent business environment of contemporary organizations and changing customer needs require continuous feedback on and improvement of both services and the IT tools supporting them. Feedback arrows in Figure 1 illustrate this. The existing services are, of course, the basis for creating improved services, and on the IT side the existing systems and system documentation can be re-used when improving the IT tools supporting the business services and functions. The experience gained from implementing a company's services and the experience of using the supporting IT tools provide information, or they may sometimes even create the incentive for reconsidering the business and IT strategies.

## 2. Research Objectives

In this study we analyze the decision making and strategic investment planning process focusing on the following dimensions: strategic planning process, decision making and control, communication, benefits management, and follow-up. We relate the case experiences to our strategic planning framework in order to verify its descriptive power. We also pursue to explain the dynamics of the framework, i.e., to establish the forces that are indispensable to keep the feedback flows running.

The research questions include how the system development gets initiated at the strategy level and how it proceeds down to the operational level. Particularly we are interested in the communication that takes place along the arrows in our framework across different levels, as well as horizontally. Decision-making takes place on both formally and informally. In the present study we investigate the formal decision-making process in order to find out how decision-making power is allocated to different organizational levels and between IT and business. Furthermore, we explore the process of control of the planning and implementation of investment objectives and the communication.

## 3. Methodology

Our research approach relies on a single case study method. We have had an access to key company representatives that we have interviewed using thematic interviews. These were audiotaped. We selected a system development case that is strategic by its nature and also encompasses the whole group of companies with presence in several countries. We have also had the possibility to cover all pertinent, documented instruction material relating to strategic planning, system development work, as well as measurement and review forms. For a comparable, interpretive case study using one company in the financial services industry, see for instance Peffers and Tuunainen [3].

## 4. The Case Organization

The case organization selected for this research is a multinational portfolio type of company in the financial services field. The company has experienced many structural changes over the last decade. The number of employees has recently grown to well over 30 000. Being a member of the top tier as to the market share, and possessing several cutting edge technology financial products, the demands of integrating the corporate members are increasing. These demands stem from

customers, who would rather see the corporation as one single supplier across borders. They also stem from within, mainly articulated in terms of increased synergies. One vehicle conceived as an enabling, integrating strategic factor is the company's WWW-based network environment.

Whereas the company was previously faced with a wide selection of related software and solutions in creating intranet and extranet content, the overall strategic aim was integration. In more precise terms, the company pursued to reduce the number of content creation environments, separate (partly custom developed) content management systems, and the number of production sites. In this pursuit, the key issues were as follows.

Firstly, the company aimed at setting up one central, packaged WCM (Web Content Management) system, available for all portfolio members. Secondly, the company wished to strengthen its identity by providing a unified set of preprogrammed artifacts in the form of symbols, labels, logotypes and layout structures, which would be easily replicated and reused. The third key issue was making the content creation and publication directly available to individual business units. In the previous system environment a business unit, at the outset, typically drafted a content document. This effort was multiplied if counter-party units in other countries also wished to draft a version of their own. There followed perhaps several rounds of reviews (times the number of content producers). Eventually one version was selected in an approval process, which again may have taken several rounds. Finally, the document was ready for publishing, and it was delivered to the chief editor – sometimes called the WEB Master. The remaining source of anxiety was the timing of publication, if there was a backlog of material queuing up. A centralized WCM was the contemporary answer for streamlining such a process. Previously, creation, approval, testing and publication procedure was judged to be cumbersome, as illustrated above. In particular, the testing and publication phases relied on a few technically oriented persons stationed apart from each other in the portfolio countries. This naturally led to coordination costs that could be eliminated with a centralized WCM system. The last issue was considered to be of utmost importance and far reaching as to its consequences. Thus, the centralized, single system was regarded as having strategic level benefits in terms of integrating business processes and streamlining the web-publication process.

## 5. Preliminary Observations

### 5.1 Strategic Planning Process

All new system development initiatives in the case company originate from business strategies, which contain strategic focus areas and targets that are, to an extent, jointly with IT converted into a development program. This is called a consolidated information systems strategy and it paves way to the system portfolio

development that is to be launched over the annual planning horizon.

The tactical level planning brings together the issues of what is the service that business wants to offer and the tools made available by information technology. This fitting task launches the actual project planning work. At this stage, IT has already nominated a responsible project manager, who acts as the coordinator and head-figure, and who also collects the evolving documentation. All procurement related decision-making is founded on both business and IT strategies.

### 5.2 Decision-making

Participants in decision-making represent all interest groups, i.e., top corporate business management, participating business units' management and IT management, either according to organizational hierarchy or in various decision-making organs. Additional participants in decision-making are specialists that possess expert knowledge in the areas under discussion. Decisions concerning project work proper are made in the project management group. Other decisions, such as the one on procurement, are made either centrally or in a distributed fashion, depending on the decision object. The decision-making authority of different organs has been defined in monetary terms. The power balance between different interest groups in decision-making organs varies by development stages. In the project planning phase business units tend to have a relatively large representation, whereas implementation phase witnesses IT's relatively dominant representation.

Project proposal requires the approval of all user organizations that shall carry the costs involved, and the top executive organ in those cases, where the proposal is classified either as strategic or financially significant, i.e., investment exceeds a preset limit. All parties to the chain of approval have access to the same set of decision documentation. In the case at hand, two business units and IT approved WCM proposal. In addition – without strict necessity – the proposal was taken to the top executive organ due to its strategic nature in overarching the whole corporate group.

There is no formal procedure to decide upon the future ownership of a system to be developed. However, in practice and also in the case of WCM it was negotiated among the future user organizations during the drafting of the project proposal. The one in charge of the preparation of the proposal coordinates the negotiations of the ownership, since invariably one owner has to be identified and explicated in the final project proposal. The guiding principle underlying the negotiations is to vest the ownership on the organizational entity to the one to draw most benefit of the future system. In a likely fashion, it is the owner that usually will carry the largest share of the financial burden post implementation.

The allocation keys to split the license fees were also under negotiations in the planning phase. At the end, due to the threat of a notable delay, allocation mechanism was decided by an executive order, where after each country

organization made a parallel approval decision on allocation keys accepting the overall allocation principle.

In order to speed up the planning phase, the persons participating as responsables made decisions concerning their individual task areas with an explicit authority of the management group. Management group was then regularly notified of these decisions in its meetings, gave feedback and guidance if deemed necessary, but in essence approved them formally.

Coming down to the operational level of the framework we observed two sets of processes. One relates on the left side of Figure 1 to the business processes. The experience proved that business participants perceived process definitions as difficult due to inexperience. In addition to having to learn a new tool (a packaged program), the users found it difficult to draft processes from a clean sheet. We could not, however, establish the relative degrees of change resistance on one hand, and professional incapability, on the other. The second set of processes took place on the right side of the framework. This related to program engineering, configurations, hardware installation settings, all of which were more straightforward than work done on the opposite side. The decisions made on IT side were more technical by their nature and their impact more forcing towards business and users.

In addition to the traditional roles of business-, IT-, and project management, the case company has also designed and adopted a role of business chief information officer ("BCIO"). The hierarchical status of a BCIO is that of a first vice president, and they number some 15. They belong to the IT organization and act by and large as account officers towards business areas. In the decision-making process their role is to see that all documentation is in place and negotiate the development issues with the customers, i.e., the business areas or their units.

### 5.3 Control

The ultimate control of project activities lies always within the investing organization, even though external consultants and experts were used. It is also commonplace to have the project manager nominated from within IT, as in the case of WCM.

Each project management group meeting follows up on accrued costs and the project's progress that are reported on a monthly basis. The project manager, assisted by IT's administrative project office organization, reports on the figures and progress using a project review form. Business units, on the other hand, are responsible for monitoring of the accrual of the stated post-implementation benefits. All system work, IT production and IT services costs are also reviewed regularly on a summary level with business unit management, - controller representatives and the relevant business chief information officer in attendance.

### 5.4 Communication

There exists a formal procedure for intra-project communication and feedback, but it is scarcely deployed. The deployment is largely dependent on the individual project managers' work habits, but additionally general haste shadowing scheduled project work may cause a degree of indifference. In the WCM project, communication and feedback have worked exceptionally well, this is seen to be a consequence of several positive factors, such as exceptional staff motivation, extrovert nature of those involved and also due to communications professionals being involved. Additionally, one of the user organizations was the group communications, which added positively to the propensity to distribute information above and in excess of strict stipulated minimum.

A common cross-country document management system was available to cater for the internal communication and collection of feedback in the WCM project. This is a common project databank, where all documentation of cross-border projects is deposited. Read-only rights to browse WCM documentation were granted to each and everyone willing to have access. This was exceptional, since such authorities are normally sparsely granted due to the repository containing documents in progress that might be interpreted as finished and approved.

Internal feedback was perceived as very useful, and it was actively collected beyond the compulsory opinions and technical statements, also on ad hoc basis. Regular statements on systems descriptions were received at points that required a quality inspection based on the systems development work model. These statements ensured that the work and the resultant documentation complied with the appropriate work instructions correctly and adequately. Expert opinions were sought in abundance, but their delivery was often random. Additional feedback was received from the project management group. In the group participating in the project work there are individuals, mainly on management level, that are regularly informed of the progress. Their commitment was perceived somewhat loose, which was also seen to lead to a very low volume of feedback from them.

After the project has been finished, a final evaluation of the work is drafted. This contains issues that have been unexpectedly successful or negative experiences. This procedure, however, is still in its early introduction phase, and therefore there is not much experience of utilizing the evaluations. It is also uncertain, to which extent these final project work evaluations will be utilized in future projects.

Production stage communication is channeled through nominated individuals. IT has appointed one person – and a substitute – towards both internal and external interest groups. In a similar fashion the application supplier and the consultant company have also a nominated first point of contact.

## 6. Initial Conclusions and Discussion

Our tentative conclusion of the descriptive power of the framework used is positive. In the WCM case used, we have been able to witness the linkages, the roles and the levels depicted, with the provision of the far sided recursive arrows that will materialize only by lapse of time. However, the procedures, (feedback mechanisms), organs, (change management meetings) and administration routines, (change prospect databank) are all in place.

We have been able to establish the three levels of decision-making, namely strategic, tactical and operational, and the role-play involved. We would like to call these levels management, architecture and engineering levels. Our main conclusion in relation to the framework is the direction of decision flow that starts from top left, moves laterally to right, returns, steps down, moves right again, returns, steps down, and finally moves right to technology and products.

Some of our observations also support a view that the dominant decision-making – and bargaining power move diagonally from top left to down right, i.e., from business to IT. This view, however, requires more extensive substantiating, although this notion of widening role of business in planning, building and running information systems has been explicated for a considerable period of time, see for example Zmud et al. [6] and Pinker et al. [4].

Another, strongly emerged phenomenon was the key role played by the relevant BCIO. Our observations indicate that he/she plays a role of a catalyst. His/hers is a domain that covers ubiquitously all development projects, planning levels and interest groups. In summary, the BCIO enables the interplay between business and IT on all lateral arrow levels. The BCIO is the chief negotiator with business, planning coordinator of the business' system architecture, and a shop-floor steward on operational level activities.

We could further witness a remarkable requirement for feedback and communication that originates from introducing a centralized system to a setting of a complex of existing systems and country specific system environments. In the case project communication worked exceptionally well, since people were motivated and the company's communications professionals participated actively in the project. The internal feedback was

facilitated through the use of a common cross-country document management system. Basically everyone willing to have access to browse the WCM documentation was granted the rights. This was perceived very useful. The linkage between the complexity of the development task (technology included) and the required volume and management of feedback and communication needs, however, to be further elaborated before anything definite can be posited.

Reengineering literature emphasizes the need to start planning from a clean sheet. A less emphasized need is the preparedness and expertise of those business representatives involved in the task. In the WCM case this appeared to be one of the trickiest tasks. It is one thing to improve gradually and fine tune existing processes than design a completely new one that is based on a predetermined logic cemented in a packaged program application.

Our aim, as the next stage, is to crosscheck further our observations through revisiting the interviewees on the basis of our documented case material. We shall also re-confirm our observations against written material, like expert opinions, decision protocols, and job descriptions. If the descriptive power of our framework still remains on at least the present level, we intend to engage in further confirmatory research through a wider survey.

## References

- [1] Gottschalk, P., 1998. Content Characteristics of Formal Information Technology Strategy as Implementation Predictors. (Thesis, PhD). AIT Otta AS.
- [2] Henderson, J.C., and Venkatraman, N., 1993, Strategic alignment: Leveraging information technology for transforming organizations, *IBM Systems Journal*, Vol. 32, No. 1.
- [3] Peffer, K. and Tuunainen, V.K., 1998, Expectations and Impacts of a Global Information System: The Case of a Global Bank from Hong Kong, *Journal of Global Information Technology Management*, Vol. 1, No. 4.
- [4] Pinker, E.J., Seidmann, A. and Foster, R.C., 2002, Strategies for Transitioning 'Old Economy' Firms to E-Business, *Communications of the ACM*, Vol. 45, No. 5, May.
- [5] Sääksjärvi, M., 2000, The Roles of Corporate IT Infrastructure and Their Impact on IS Effectiveness, Hansen-Bichler-Mahrer (ed:s), *Proceedings of the 8<sup>th</sup> European Conference on Information Systems ECIS 2000*, 421-428.
- [6] Zmud, R.W., Boynton, A.C. and Jacobs, G.C., 1986, The Information Economy: A New Perspective for Effective Information Systems Management, *Data Base*, 16, No.1, Fall

# An Example of E-Commerce Platform in Anhui Tobacco Corporation

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## Abstract

Anhui Tobacco Corporation (ATC) is a large state-owned group corporation. After a long period of planned economy system, ATC is not suit for marketing economy. With rigid management method, bad service and high trade cost, ATC is weak in competition. Shortly after 1-year's construction, ATC built up an E-commerce platform which has the largest bargain and perfectly combines the traditional industry with modern information technology. The information system is based on a network connecting all the subordinate factories, branches and wholesale center. It is centered by e-business, including e-commerce platform, centralized fund management system, and ERP for manufacturing factories and MIS for sales firms will be applied later. Since the platform went into operation in Oct.,2001,an average of thousand boxes of cigarette has been dealt. Up to March,2002, the trading fund amounts to 400 million yuan. This figure is forecasted to be one billion in 2002. At the same time, income grows rapidly. The allot income increases 24% compared with the same period last year; wholesale increases 14%, profit increases 21%. Information system must service the strategy target, and be driven by management innovation. The success is due to idea renewing, leadership, organization and Training from beginning to end.

## 1. Introduction

By the end of 2000, Anhui Tobacco Corporation (ATC) was still backward in information system, far behind such advanced provinces as Shanghai, Yunnan and Hunan. Shortly after 1-year's construction, ATC built up an E-commerce platform which has the largest bargain and perfectly combines the traditional industry with modern information technology. The success is due to idea renewing, leadership and organization. All enterprises preparing to construct e-commerce can learn much from this case.

## 2. Background of E-commerce construction

ATC has 23 subordinate organizations, including 8 factories, 17branches, with a totaling staff of 20000. It has 7000 wholesale net terminals, 27 retail shops. After a long period of planned economy system, ATC is not suit for marketing economy. With rigid management method, bad service and high trade cost, ATC is weak in competition.

In order to survive and grow rapidly in the new era of knowledge economy and information, ATC must solve two main problems. First, inside the corporation, it must

standardize production, strengthen management, re-organize management structure. Second, outside the corporation, it must setup a strict rule for tobacco market, blow away imitate and forge product. ATC undertook the above work before, but no better effect was achieved because of heavy job, bad organization and weak method. In the new era, this can be achieved by information system to guarantee the growth target.

## 3. Procedure of E-commerce system construction

### 3.1 Re-construction of marketing net up to sky and down on earth

According to administration region, geographic environment and economic region, ATC redesigned its business flow, logistic flow and inspection flow, and built up a network covering all the cities, counties and towns throughout the province. This net has 7156 sales routes, 6361 distribution routes and 7386 inspection routes. With an effort of standard service, sending goods directly to customers etc., the net is more complete, more unblocked and more effective. It is also a ready platform for the e-commerce platform to be constructed later.

### 3.2 Weaving a network up to sky and down on earth

The first step in constructing ATC tobacco information system is to build a computer network connecting all the subordinate factories, branches and wholesale center. By the end of 2000, ATC begin to invest several million yuan to construct the industrial private net that is 'up to sky and down on earth' with the principle of 'International standard, Chinese characteristic and suitable for Anhui'. In the sky, ATC links with China Tobacco Corporation through satellite; on the earth, ATC connects its subordinates, wholesale centers, inspection branches and banks through DDN,PSDN. The net will be further connects to workshops, machines and customers in the future.

The private net is used not only for data transmission, but also for other applications. The internal IP-phone system is used by all users throughout the province with a charge of zero. The video meeting system is normally in use for tobacco industrial meeting and training. Everyone can discuss business and learn new technology in his own office, saving a large amount of money that is needed for traveling. The inter- and extra- web sites are open to visitors inside and outside ATC.

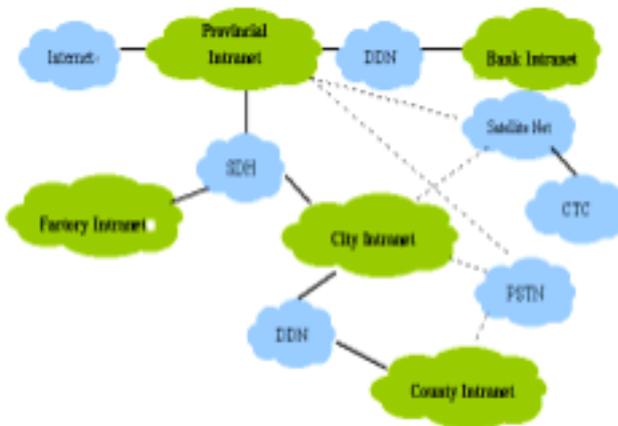


Fig.1 The Top Structure of ATC Intranet/Extranet

### 3.3 Innovation drives information system

Information system must service the strategy target, and be driven by management innovation. During the construction of information system, ATC invented many innovative methods.

The first is innovation of marketing network.. ATC built up a multi-dimensional marketing system covering information flow, currency flow and goods flow. The most significant innovation is centralized logistics, centralized customer visiting and centralized inspection. With specialization and division, such phenomenon as practicing fraud and secret bribery is eliminated completely, which ensures the purity of business.

The second is the innovation of managing idea. In 2000, ATC stated that 'Retail shops are our parents of living'; in 2001, ATC further raised the idea to 'Service is of outmost important; Customers should be respected everywhere'. With the application of methods in Customer Relationship Management, ATC setup a system of customer management, which focuses on improving customer's satisfaction, contribution and loyalty. This system tried hard to achieve a state that the co-operation between ATC and customer is distance-zero, customer's cost of purchase is zero, and customer's complain on service is zero. In this state, customer's resource and value can be fully mined.

Thirdly is the innovation of management system. ATC pays yearly salary for the main leaders of its subordinate organizations according to their work achievement. The application of yearly salary stimulated these leaders as were as provide a standard of assignment for them.

The fourth is the innovation of work examination. In the past 2 years, ATC did not assign such quota as profit, tax or selling. It assigned a new examination quota system mainly concerning the quality of operation. For subordinate organization, the quota is increase of growth; for salesmen, it's income and gross profit; for monopoly staff, it's quantity and purity of the market; and for all leaders, the main examination quota is the quality of their

work. This new examination system is more rational. It released all the people from traditional quota, enabling them to do more important work.

## 4. Application of software centered on e-commerce

### 4.1 The strategy of software application

In 1993, ATC began to build its information system, but the application goes slowly. Later, ATC developed a set of software named 'ATC Business Information System', which was appraised by China Tobacco Corporation in 1996. There were only four users by the end of 1998.

Entering 2000, the information system and their blocks still remained isolated from each other, forming many 'information islands'. The network equipments were out of fashion, only connecting cities. In such environment, ATC was hesitated to start e-commerce. Will the e-commerce platform become a mirage in this loose base of information system? Should we start from the very beginning in a traditional way? By that time, there was no complete e-commerce platform in our nation. Should we wait until other company builds a model?

It is risky to invest a large amount of money and build an information system. Such system may look vast, but it can't run smoothly. Therefore, ATC determined a strategy of planning totally and implementing progressively. First of all, ATC plans to build a e-commerce platform with the function of cigarette dispatching, transporting and accounting, ignoring the demand of factories and retails. After the platform operates in good condition, the logistic management is completed, and the market environment is improved, ATC will prolong the platform to B-C, and finally B-B including firms both inside and outside. At that time, online purchasing and selling will be achieved.

The basic idea of constructing ATC's e-commerce system is to achieve standardization through information system and build up a scientific management system. The system is centered by e-business, including e-commerce platform, centralized fund management system, ERP for manufacturing factories and MIS for sales firms. The



Fig.2 Framework of ATC information System

main frame of the system is shown in Fig 2.

#### **4.2 E-commerce trade platform**

E-commerce platform is a trade and managing tie connecting producers, agents, customers and banks. In order to be easily operated, ATC first built a B-B e-commerce platform which has a vast amount of trade. The platform is open to tobacco 8 factories, 17 branches, all the wholesale centers and 2 banks. The procedure includes web ordering, electric approval, online payment and logistics. It takes only 10-20 minutes to process an order.

As known to all, e-business has three difficult problems in China: safety, payment and material flow. Many e-business companies lost a lot in these problems. But with the superiority in tobacco industry, ATC ingeniously solved the problems.

First, the ATC's network is a sealed network in tobacco industry, not opened to outside yet. Therefore, enterprises outside tobacco industry can't trade in the e-commerce platform. On the surface, it seems to contrast the rule of opening advocated by e-business. But actually, it is this sealed network that ensures the safety in the not matured social environment. With all the traders being brothers inside the industry and strict control, no business cheat can appear.

Secondly, the rule of paying first and delivering second also avoids the debt crisis often appeared in such inside-industrial trading. Therefore, if relative enterprises are all involved in the e-commerce platform, the real time accounting can be achieved and the main problems become only technology and skill.

Thirdly, ATC connect the e-commerce platform with information systems in Industrial and Business Bank and Agriculture Bank by special lines. A machine located between information systems transmits data and ensures the safety. In this method, cigarette factories open bank accounts in both banks, and the sales companies in cities and counties open only one account in either bank. The purpose of cooperation with two banks is to avoid the difficulty of financial accounting between banks. At the same time, this structure can guarantee the platform running in good condition. If one bank has any problem, the other can be a 'backup'. The result of competition between two banks is better service.

Finally, the logistics network constructed by ATC itself ensures the material flow. A high-lever centralized dispatching center is built in each city. There are 6,159 delivery lines, 2,974 delivery cars in ATC. In cities and towns, the delivery occurs at least one time in 2 days to each retails, and in countryside, it occurs at least one time in 3-4 days.

Since the platform went into operation in Oct., 2001, an average of thousand boxes of cigarette has been dealt.

Up to March, 2002, the trading fund amounts to 400 million Yuan. This figure is forecasted to be one billion in 2002. Anhui tobacco industry has preliminarily realized internet ordering, trading, and payment. The platform can also trace the whole procedure of any business, display trading status simultaneously, and provide reports automatically for managers throughout the province. The application of e-commerce re-constructed the marketing system as were as the model of management, which ensures the policies such as 'payment first, delivery second' to be strictly carried out. By now, the platform is the largest B-B electronic commerce platform in China.

#### **4.3 Fund management centralization and account system**

It's important to centrally manage fund for groups as ATC. With Fund management centralization, flexible operation, safety and accuracy can be ensured, and the operation cost can be reduced. Several years ago, ATC began to centrally manage its fund. But with weak means of management, the target could not be achieved. After the operation of e-commerce platform, the fund management centralization and account system is also ignited, which connect tightly to the platform.

Now, all the 66 members are using this system. Every member has an independent account number and has the right of determining its own fund. The department of financial affairs can inspect the fund flow through network. It can also regulate the requirement and surplus of fund between two or more subordinate members. One member can lend its fund to another without the help of banks. From inner load applying to plan balancing, financial approving and lender's approving, it takes only minutes. The result is that the efficiency is improved, the total loan of ATC decreases rapidly and financial cost reduced greatly. Restricting only to financial cost, a total saving of about 50,000,000 Yuan is predicted.

The e-commerce system is not isolated. The supplement software such as Office Automation, Sales and Service come into operation last year. ATC plans to apply CRM, SCM in 2002 after the stable operation of e-commerce platform. It also plans to apply ERP to manufacturing factories in the near future. These systems will makeup a complete information system, centralized on e-commerce, connecting both inside and outside Anhui Tobacco Industry.

#### **5. Benefit of e-commerce application**

The following figure best shows the benefit of e-commerce application in Anhui Tobacco Industry.

Income grows rapidly. The allot income increases 24% compared with the same period last year; wholesale increases 14%, profit increases 21%. The wholesale gross profit ratio of cigarette product achieves 18.65% with an increase of 4.9%. The ratio of profit plus tax vs capital

increases 14 percentage. The ratio of capital income increases 12%. The storage of cigarette remains 200,000 boxes, a 110,800 boxes' below the control lever of assigned by China Tobacco Corporation. The total profit plus tax increases 34%. The productivity increases 28.7%.

The efficiency of fund utilization increases greatly. The total loan of Anhui Tobacco Industry decreases from 330 million Yuan in 1999 to 160 million Yuan in 2001. It will become zero by the end of March, 2002. This has an interest saving of about 10 million Yuan. At the same time, the harmful capital decreases. Through resource reconstruction, the total capital of ATC decreases from 1130 million in 1999 to 960 million now. The total debt decreases from 730 million to 532 million. The existing stock decreases from 300 million to 220 million.

With re-organization, department decreases 46%, management staff decreases 34%, financial cost decreases 54%, sales income increases 17%, total profit increases 242%.

The brand begins to centralize. The number of Brands of ATC decreases from 70 to 52. The number of brand which has a sales income over 100 thousand boxes increase from one to four.

## **6. Realization in e-commerce construction**

### **6.1 The renewing of idea is the fundamental requirement in information system construction**

Compared to first-rate tobacco companies in the world, ATC is far behind in production, management, technology etc.. The backward of management is extremely obvious, which mainly appeared in management idea. The practice of ATC e-commerce construction shows that, the most difficult problem lying in information system construction is neither technology nor fund, but the renewing of management ideas.

Shortly in one year of 2001, ATC completed over 10 important projects of system construction including computer network, e-commerce, fund centralization, office automation, bank accounting, group IP phone, video meeting and so on. If we followed the prescribed order, it's impossible to finish so many projects. Only when we take an idea of standing in a high lever, constructing simultaneously and arousing all the staff can we make the significant achievements.

For example, in the construction of computer network, ATC took the potential resource of the network in the future as its bargain weight. With the result of visit bids, the investment of the net became zero, and the yearly rent of was settled in 2 million. Besides, the bank provided the interface equipment valued over 4 million. This result is far bellow the budget of 20-30 million fund investment and nearly 10 million yearly rent.

### **6.2 Overall arrangement is the necessary prerequisite**

E-commerce system must be constructed to meet the practical requirement of enterprise. It must have an overall plan with obvious key points, sufficient fund and manpower. Meanwhile, the system must solve the most difficult problem. The procedure of construction must be focused on raising the competence of enterprise. With the principal of advanced in technology, practical, we must act according to our ability in order to invest little and harvest much.

### **6.3 Top leader's project**

To describe the importance of e-commerce construction, we often use the words of 'top leader's project'. It doesn't merely mean people and fund investment. First of all, the top leader must be confident. The construction is a process of standardization, reformation and innovation accompanied by the re-allocation of right and benefit. It's a new challenge to both the leader and the staff. Therefore, the leader must be confident himself and transfer this confidence to all the staff. Otherwise, the information systems are impossible to be constructed.

Secondly, the top leader must control the direction. He must be participated in distributing limited resource, inspecting the rate of progress, undertaking supplementary reform, coordinating departments and grasping the best chance. Finally, he must provide a priority of both fund and manpower to the system. The top leader of ATC takes the information system as an important part of ATC's strategy, and he has done much to guarantee the smooth construction of the system.

### **6.4 E-commerce requires many compound talents**

Talents are essential to e-commerce. Talent shortage is normal to most enterprises. There are two ways to solve the problem. One is to train own talents, and the other is to import from the outside. But the most important to the enterprise is to setup a system of talent usage. An environment of 'respect knowledge, respect talent' is highly needed to solve the problem of 'talents is difficult to be imported and hard to be kept'. The compound talents, who have the knowledge of both information technology and management, must be promoted to important position.

### **6.5 Training from beginning to end**

With the progress of e-commerce construction, ATC undertook training engineering from beginning to end. The training center which is responsible to training, launched 40 training classes. Over 5,000 people were trained there. ATC also raised classes of EMBA and Master of Engineering with universities. About 50 people study in the class in their spare time. ATC set the target of its rank construction as 'Intelligent workers, thinking cadres and researching leaders'. It is trying to build the corporation into a learning organization. With the overall quality improvement of both staff and the enterprise, the

competence of ATC is improving everyday.

## References

- [1]Donald J. Bowersox, David J. Closs, *Logistical Management: The Integrated Supply Chain Process*, McGraw-Hill Companies, Inc., 1998
- [2]Hanson, W. *The Principles of Internet Marketing*, South-Western College Publishing, 2000
- [3]Robert W. Veryzer,Jr. J, *Key Factors Affecting Customer Evaluation of Discontinuous New Products*, RPD OMMPVMANAG 1998, 15:13
- [4]Simon Knox,*Loyalty-Based Segmentation and the Customer Development Process* ,European Management Journal Vol. 16, No. 6

# ePrice Comparator: An Automated Internet Price Comparison System

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## Abstract

The World Wide Web is a perfect medium for electronic retailers who specialize in cutthroat price competition (Coyle, 2002; Shulman, 1999; Wingfield, 2002). Amazon.com, for instance, has been taking a leading role in an on-line bestseller price war. In May of 1999 when Amazon.com cut its list price for bestsellers in half, Barnesandnoble.com and Borders.com quickly followed. Again, in 2002, a second price war started when Amazon lowered the minimum order size of \$49 from \$99 to qualify its customers for free shipping on most items - its fourth price cut in the past 11 months. The battle for the lowest prices among e-retailers has left most Internet shoppers little incentive to go bargain hunting at other sites (Mossberg, 2000).

E-retailers must monitor and collect competitors' price information in order to win the raging price war and increase e-commerce sales. In order to do this, office personnel are usually assigned to manually search and read price changes from competitors' Web sites. However, such a process is arduous, costly and inefficient. In an attempt to reduce cost and improve efficiency in price gathering process, inquiry is being made into ways of automation and computerization. This paper describes the design and development of an Internet application system, code named "ePrice Comparator," that automates the monitoring and collecting of prices from Web sites of targeted competitors on an hourly basis.

Users of this system will be able to access the program from an Intranet. After setting up the targeted retailers and particular products to search for, the user will trigger the comparator to get price information from those retailers' websites. Once the comparison is done, the prices will be listed along with retailers' names in a database for future analysis. By analyzing the data, the user will be able to figure out the current market situation for a particular product and adjust his price position. Note that the process of searching and reading prices from the targeted Web sites is automated by setting up time scheduling service of the operating system where the comparator is being hosted.

The system was developed in Visual Basic 6 with the use of a Microsoft SQL database server. The code modules of the system include a HTTP COM object that downloads targeted HTML pages, a HTML parser that

extracts desired pricing information, and a network of business object components that provide the data retrieval process and provide reporting services.

The system is also designed to have an easy-to-use interface with customizable functions and an open system available for future add-ons. The interface is basically comprised of three different administration panels. Within each panel, there are tabs to group different functionalities to allow for smooth operations. The three panels are database administration panel, parser administration panel, and the search engine panel. The database administration panel allows the user to set up targeted retailers' demographical data, URLs, and targeted HTML pages where the price information is stored. The parser administration panel enables the user to find the right position of price information in the targeted HTML page through analyzing the table tab structure of the page. The result of the parsing and the HTML page analysis is a template containing a set of positioning numbers for the targeted pages. The template is then stored in the database for run-time downloading and parsing when the search engine is activated. Finally, the search engine panel provides facilities for the user to configure when and how the engine is run once the system is activated from the hosting operating system.

ePrice Comparator can be scheduled to run at any interval as needed. The result of each run is stored in the database for analysis. One of the key features of the system is its capability to publish the analysis report in HTML format, which enables corporate managers to view the report from anywhere at anytime and makes price monitoring a ready-to-employ management practice.

In this newly-emerged and highly-interdisciplinary ecommerce domain, systems development is a key research methodology that interacts with other methodologies, such as theory building, experimentation, and observation. The advancement of ecommerce research and practice often comes from new system concepts, but systems must be developed first to test and measure the underlying concepts. ePrice Comparator is a result of such a proof-of-concept approach.

## Bibliography

- [1] Coyle, Stephen. “e-Retailing Update—Shopping in the 21<sup>st</sup> Century.” Real Estate Finance 17 (2000): 21-30.
- [2] <http://www.faqs.org/faqs/internet/info-research-faq/part6/>
- [3] Kobayashi, Mei. “Information Retrieval on the Web.” ACM Computing Surveys Jun. 2000: 144-173.
- [4] Mossberg, Walter. “The Amazon Way is Best Model for Web Shopping.” The Wall Street Journal 24 Sep. 2000:H-3.
- [5] O’Rourke, Maureen. “Shaping Competition on the Internet: Who Own Product & Pricing Info?” Vanderbilt Law Review Nov. 2000: 1965-2006.
- [6] “Retailers Fear Price War is Moving onto the Web (Music Industry Retailers).” Billboard 21 Mar. 1998:3-5.
- [7] Shulman, Richard. “Making the Web Work for the Independent.” The Wall Street Journal 25 Jan. 1999: B-5.
- [8] Wingfield, Nick. “Amazon, Buy.com Start Price War on the Internet.” The Wall Street Journal 25 Jun. 2002: B-15.

# The Impact of Early Order Commitment on the Performance of a Simple Supply Chain \*

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## Abstract

An example of supply chain coordination is early order commitment, wherein a retailer commits to purchase a fixed-order quantity and delivery time from a manufacturer before the real need takes place. In this paper, an analytical model is developed that quantifies the impact of early order commitment on the performance of a simple two-level supply chain consisting of a single manufacturer and a single retailer. The model reveals that the effect of early order commitment depends on a lot of factors such as the cost structure of the supply chain, the lengths of manufacturing and delivery lead times, and the correlation of the demand over time. This model can be used to evaluate the benefit of early order commitment, to determine the optimal early commitment periods of the supply chain, and to estimate the maximum incentives the manufacturer can provide to encourage the retailer to commit its orders in advance.

*Keywords: Supply Chain Coordination, Early Order Commitment, Inventory Control*

## 1. Introduction

Effective supply chain management requires coordination among the various members in a supply chain. Through coordinating activities across the boundaries of firms in a supply chain, it is believed that significant benefits can be achieved for the partners and the entire supply chain. Previous research has recognized different approaches for supply chain coordination, including information sharing -- sharing real-time demand data collected at the point-of-sales with upstream suppliers ([1],[6], [7]). A further-developed method concerning the effective use of such information suggests a centralized forecasting mechanism that accesses the final demand ([2], [3], [8]). These investigations reveal that information sharing can significantly enhance the performance of the supply chain by reducing the bullwhip effect, a negative phenomenon of demand variability amplification along a supply chain from downstream members to their suppliers.

Recently, as another alternative form of supply chain coordination, early order commitment has drawn attention from the researchers and practitioners. Early order

commitment means that a retailer commits to purchase a fixed-order quantity and delivery time from a manufacturer before the real need takes place. [5] presented an analysis for a steel distribution supply chain, and quantified the benefits for the consumers who commit orders in advance. [9-11] conducted extensive simulation studies on the effect of early order commitment on supply chain performance under various operational conditions. These researches show that under some cases, practicing early order commitment can generate significant cost savings in the supply chain. [4] examined the tradeoff between strategic early order commitment and postponement. Generally speaking, the impact of early order commitment on the supply chain performance is intuitively clear. On one hand, early order commitment increases a retailer's risks of over-estimating the demand; On the other hand, it helps the manufacturer reduce planning and executing costs. In order to accept early order commitment to achieve best performance for the entire supply chain, the members at different levels of the supply chain should make optimal tradeoff based on careful evaluation of both the negative effect for the retailer and the positive effect for the manufacturer. Unfortunately, up to now, no general analytical model is available to quantify the integrated effect of early order commitment and to guide such kind of tradeoff decisions. Besides, a fundamental question about early order commitment is why should a retailer make commitment (with penalty charge) if information sharing (without cost penalty for order commitment) can provide equal or close enough benefits!

This paper aims at proposing an analytical model to quantify the impact of early order commitment on the performance of a simple two-level supply chain consisting of a single manufacturer and a single retailer. The model reveals the effect of early order commitment depends on a lot of factors such as the cost structure of the supply chain, the length of manufacturing and delivery lead time, and the correlation of the demand over time. Furthermore, under some cases, significant benefit can be achieved for the supply chain even under the environment with information sharing. This model can be used to evaluate the benefit of early order commitment, to determine the optimal early commitment periods of the supply chain, and to estimate

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the maximum incentives the manufacturer can provide to encourage the retailer to commit its orders in advance.

## 2. Supply Chain Model

### 2.1 Basic Assumptions

The basic assumptions underlying the model in this paper is similar to the one proposed by LST. The supply chain is assumed to be a simple one consists of a single manufacturer and a single retailer. Only the retailer faces external demand for a single product, and the demand is assumed to be a simple autocorrelated AR(1) process, i.e., the demand in period  $t$  is

$$D_t = d + \rho D_{t-1} + \varepsilon_t, \quad (1)$$

where  $d > 0$ ,  $-1 < \rho < 1$ , and  $\varepsilon_t$  is *i.i.d.* normally distributed with mean zero and variance  $\sigma^2$ . We also assume that  $\sigma$  is significantly smaller than  $d$ , so that the probability of negative demand is negligible. Furthermore, the demand process and its characteristic parameters are common knowledge, i.e., both the retailer and the manufacturer know the demand distribution in (1) and the values of the parameters  $d, \rho$ , and  $\sigma$ . LST gave some evidences to show that the assumption of AR(1) demand process with known characteristic parameters is reasonable in real world supply chain management when demand information is shared from the retailer to the supplier.

The manufacturing leadtime for the manufacturer (including the leadtime for the replenishment of raw materials from the external suppliers) is a constant  $L$ , and the delivery leadtime from the manufacturer to the retailer is a constant  $l$ . The most important feature of the current paper is that we incorporate an early order commitment period ( $A$ ) to the system. Early order commitment period is the number of the time periods that the retailer places her order in advance.

Both the retailer and the manufacturer use the order-up-to policy, a periodic reviewing policy which is optimal for the stochastic inventory system without fixed ordering cost, to make their ordering (or manufacturing) decisions with the review interval being one period (i.e., daily review). The events occur in sequence as follows. Before the end of period  $t$ , after demand  $D_t$  has been realized, the retailer places her order of size  $O_t$  based on her inventory level. Please note that, because of the early order commitment, this order is scheduled for the period  $t+l+A+1$ , not for the period  $t+l+1$ . That's to say, because of the early order commitment period  $A$  and delivery leadtime  $l$ , this order will arrive the retailer at the beginning of period  $t+l+A+1$ . If the retailer does not hold enough stock to satisfy the demand, the excess demand is backordered. When the manufacturer receives this order from the retailer, she does not need to ship the order  $Q$  to the retailer immediately. In fact, the quantity the manufacturer must ship to the retailer is the order placed by the retailer  $A$  periods ago, i.e. the order of size  $Q_{t-A}$ . We assume that this order must always be completely filled by the manufacturer. This means that if the manufacturer does not

hold enough stock to fill the order, she can obtain any quantity of the product from an external source with a penalty cost, where the same quantity of the product must be provided by the manufacturer to resupply the external source later. Finally, the manufacturer places his manufacturing order of size  $Q$  based on his inventory level. This order will arrive at the beginning of period  $t+l+1$ .

### 2.2 Retailer's Ordering Decision

Let  $S_t$  be the retailer's order-up-to level in period  $t$ , minimizing the total expected holding and shortage costs in period  $t+l+A+1$ . Comparing our case with the case in LST, we found that the only difference is that in LST's case, the retailer's order must cover the demand uncertainty up to  $t+l+1$ , while in our case the retailer's order must cover more periods' demand uncertainty, i.e., the uncertainty up to  $t+l+A+1$ . In fact, if we take the value  $l+A$  as the leadtime periods, then all the behavior of the retailer will be the same as in LST.

Denote  $X_t$  as the total demand during periods  $[t+1, t+l+A+1]$ , then using (1) we have

$$\begin{aligned} X_t &= \sum_{j=1}^{l+A+1} D_{t+j} \\ &= \frac{1}{1-\rho} d \sum_{j=1}^{l+A+1} (1-\rho^j) + \rho(1-\rho^{l+A+1})D_t \\ &\quad + \sum_{j=1}^{l+A+1} \sum_{i=0}^{l+A-j+1} \rho^i \varepsilon_{t+j} \end{aligned} \quad (2)$$

From (2),  $X_t$  is a normal distributed variable with the mean value

$$\begin{aligned} m_t = E(X_t) &= \frac{d}{1-\rho} (l+A+1) - \sum_{j=1}^{l+A+1} \rho^j \\ &\quad + \frac{\rho(1-\rho^{l+A+1})}{1-\rho} D_t \end{aligned} \quad (3)$$

and the variance

$$v_t = Var(X_t) = \frac{\sigma^2}{(1-\rho)^2} \sum_{j=1}^{l+A+1} (1-\rho^j)^2. \quad (4)$$

Thus the order-up-to level

$$S_t = m_t + k\sqrt{v_t}, \quad (5)$$

where  $k$  is the safety stock factor depending on the unit holding cost  $h$  and unit shortage penalty cost  $p$ . In fact, if  $\Phi$  is the standard normal distribution function, then

$$k = \Phi^{-1}\left(\frac{p}{h+p}\right). \quad (6)$$

Therefore the retailer's order quantity at period  $t$  is

$$\begin{aligned} O_t &= D_t + (S_t - S_{t-1}) \\ &= D_t + \frac{\rho(1-\rho^{l+A+1})}{1-\rho} (D_t - D_{t-1}). \end{aligned} \quad (7)$$

### 2.3 Manufacturer's Ordering Decision

Throughout this paper, we assume that the early order commitment period  $A$  is no more than the manufacturing leadtime  $L$ , i.e.,  $0 \leq A \leq L$ , since committing the orders even earlier is harmful to the retailer and not beneficial to

the manufacturer. Please note that  $A=0$  corresponds to the case that the supplier does not commit orders to the manufacturer in advance. As we have pointed out in Section 2.1, the quantity the manufacturer must ship to the retailer in period  $t$  is the order placed by the retailer  $A$  periods ago, i.e. the order of size  $Q_t$ . From (1) and (7), we have

$$O_{t+1} = d + \rho O_t + \frac{1 - \rho^{L+A+2}}{1 - \rho} \varepsilon_{t+1} - \frac{\rho(1 - \rho^{L+A+1})}{1 - \rho} \varepsilon_t. \quad (8)$$

Repeating to use (8) gives

$$O_{t+i} = \frac{1 - \rho^i}{1 - \rho} d + \rho^i O_t + \frac{1 - \rho^{L+A+2}}{1 - \rho} \varepsilon_{t+i} + \sum_{k=1}^{i-1} \rho^{L+A+1+k} \varepsilon_{t+i-k} - \frac{\rho^i(1 - \rho^{L+A+1})}{1 - \rho} \varepsilon_t. \quad (9)$$

Denote  $Y$  as the total orders that must ship by the manufacturer during periods  $[t+1, t+L+1]$ , then

$$\begin{aligned} Y_t &= \sum_{j=1}^{L+1} O_{t-A+j} = \sum_{j=1}^A O_{t-A+j} + \sum_{j=1}^{L-A+1} O_{t+j} \\ &= \sum_{j=1}^A O_{t-A+j} + \frac{d}{1 - \rho} \left[ (L - A + 1) - \frac{\rho(1 - \rho^{L-A+1})}{1 - \rho} \right] \\ &\quad + \frac{\rho(1 - \rho^{L-A+1})}{1 - \rho} O_t + \frac{1}{1 - \rho} \sum_{j=1}^{L-A+1} (1 - \rho^{L+1+3-j}) \varepsilon_{t+j} \\ &\quad - \frac{\rho(1 - \rho^{L-A+1})(1 - \rho^{L+A+1})}{(1 - \rho)^2} \varepsilon_t. \end{aligned} \quad (10)$$

Let  $T_t$  be the manufacturer's order-up-to level at the end of period  $t$ . We assume that the retailer shares her demand information to the manufacturer, thus the manufacturer knows both the retailer's order quantity and demand error  $\varepsilon_t$  up to period  $t$ . Raghunathan (2001) showed that the cases with information sharing and without information sharing do not make a great difference.

From (10),  $Y_t$  is a normal distributed variable with the mean value

$$\begin{aligned} M_t = E(Y_t) &= \sum_{j=1}^A O_{t-A+j} + \frac{d}{1 - \rho} \left[ (L - A + 1) - \frac{\rho(1 - \rho^{L-A+1})}{1 - \rho} \right] \\ &\quad + \frac{\rho(1 - \rho^{L-A+1})}{1 - \rho} O_t - \frac{\rho(1 - \rho^{L-A+1})(1 - \rho^{L+A+1})}{(1 - \rho)^2} \varepsilon_t. \end{aligned} \quad (11)$$

and the variance

$$V_t = Var(Y_t) = \frac{\sigma^2}{(1 - \rho)^2} \sum_{j=1}^{L-A+1} (1 - \rho^{L+1+3-j})^2. \quad (12)$$

Thus the order-up-to level

$$T_t = M_t + K \sqrt{V_t}, \quad (13)$$

where  $K$  is the safety stock factor depending on the unit holding cost  $H$  and unit shortage penalty cost  $P$ . In fact, if  $\Phi$  is the standard normal distribution function, then

$$K = \Phi^{-1}\left(\frac{P}{H+P}\right). \quad (14)$$

Therefore the manufacturer's order quantity at period  $t$  is

$$\begin{aligned} Q_t &= O_t + (T_t - T_{t-1}) \\ &= O_t + \frac{\rho(1 - \rho^{L-A+1})}{1 - \rho} (O_t - O_{t-1}) \\ &\quad - \frac{\rho(1 - \rho^{L-A+1})(1 - \rho^{L+A+1})}{(1 - \rho)^2} (\varepsilon_t - \varepsilon_{t-1}). \end{aligned} \quad (15)$$

### 3. Supply Chain Performance

In this section we evaluate the performance of the supply chain in terms of inventory holding and shortage cost.

#### 3.1 Supply Chain Cost

According to LST (2000), the retailer's and manufacturer's expected inventory holding and shortage costs in a period can be expressed, respectively, as

$$c = \sqrt{v_t} [(h + p)F(k) + hk], \quad (16)$$

$$C = \sqrt{V_t} [(H + P)F(K) + HK], \quad (17)$$

where  $F(\bullet)$  is the right loss function for the standard normal distribution, i.e.,

$$F(x) = \int_x^\infty (z - x) d\Phi(z). \quad (18)$$

Thus the percentage of the retailer's cost increasing in a period due to early order commitment is

$$\begin{aligned} \Delta c &= (\sqrt{v_t} - \sqrt{v_t}|_{A=0}) / \sqrt{v_t}|_{A=0} = \sqrt{v_t} / \sqrt{v_t}|_{A=0} - 1 \\ &= \sqrt{\frac{\sum_{j=1}^{L+A+1} (1 - \rho^j)^2}{\sum_{j=1}^{L+1} (1 - \rho^j)^2}} - 1 \\ &= \sqrt{1 + \frac{\sum_{j=1}^{L+A+1} (1 - \rho^j)^2}{\sum_{j=1}^{L+1} (1 - \rho^j)^2}} - 1 \end{aligned} \quad (19)$$

and the percentage of the manufacturer's cost saving in a period due to early order commitment is

$$\begin{aligned} \Delta C &= (\sqrt{V_t}|_{A=0} - \sqrt{V_t}) / \sqrt{V_t}|_{A=0} = 1 - \sqrt{V_t} / \sqrt{V_t}|_{A=0} \\ &= 1 - \sqrt{\frac{\sum_{j=1}^{L-A+1} (1 - \rho^{L+1+3-j})^2}{\sum_{j=1}^{L+1} (1 - \rho^{L+1+3-j})^2}} \\ &= 1 - \sqrt{1 - \frac{\sum_{j=L-A+2}^{L+1} (1 - \rho^{L+1+3-j})^2}{\sum_{j=1}^{L+1} (1 - \rho^{L+1+3-j})^2}} \end{aligned} \quad (20)$$

According to (16) and (17), the total cost of the supply chain is

$$\begin{aligned} SC &= c + C \\ &= \sqrt{v_t} [(h + p)F(k) + hk] + \sqrt{V_t} [(H + P)F(K) + HK]. \end{aligned} \quad (21)$$

In order to simplify the expression, we introduce a cost structure ratio ( $r$ ) to represent the cost structure of the supply chain. Specifically, we define

$$r = [(h + p)F(k) + hk] / [(H + P)F(K) + HK]. \quad (22)$$

Then the percentage of the entire supply chain's cost saving in a period due to early order commitment is

$$\begin{aligned} \Delta SC &= [(c + C)|_{A=0} - (c + C)] / (c + C)|_{A=0} \\ &= 1 - \frac{r\sqrt{v_t} + \sqrt{V_t}}{(r\sqrt{v_t} + \sqrt{V_t})|_{A=0}} \\ &= 1 - \frac{r\sqrt{\sum_{j=1}^{l+A+1} (1-\rho^j)^2} + \sqrt{\sum_{j=1}^{L-A+1} (1-\rho^{L+l+3-j})^2}}{r\sqrt{\sum_{j=1}^{l+1} (1-\rho^j)^2} + \sqrt{\sum_{j=1}^{L+1} (1-\rho^{L+l+3-j})^2}}. \end{aligned} \quad (23)$$

Obviously,  $\Delta c > 0$  and  $\Delta C > 0$  are both increasing function with respect to the early order commitment period  $A$ . Formula (19) shows that the retailer's relative cost increase due to early order commitment depends on the correlation of the demand process, the delivery leadtime from the manufacturer to the retailer, and the early order commitment period. Besides these three factors, formula (20) shows that another factor, the manufacturer's replenishment leadtime, affects the manufacturer's relative cost saving. Furthermore, formula (23) shows that the cost structure ratio also affects the integrated performance of the whole supply chain due to early order commitment. However, these results reveal that although the variance of the error item in the demand process (1) amplifies the absolute values for the costs, it does not have any impact on the relative cost increase or decrease for the retailer, the manufacturer, and the whole supply chain, unless there is no demand uncertainty (i.e., the variance of the error item is zero).

From (23), we can easily obtain the following condition where the early order commitment is beneficial to the whole supply chain:  $\Delta SC > 0$ , or equivalently

$$\begin{aligned} & r\sqrt{\sum_{j=1}^{l+A+1} (1-\rho^j)^2} - \sqrt{\sum_{j=1}^{l+1} (1-\rho^j)^2} \\ & < \sqrt{\sum_{j=1}^{L+1} (1-\rho^{L+l+3-j})^2} - \sqrt{\sum_{j=1}^{L-A+1} (1-\rho^{L+l+3-j})^2}. \end{aligned} \quad (24)$$

This is the critical condition that guides us to determine whether we should use the early order commitment or not in a supply chain. The smaller the cost structure ratio  $r$ , the more that early order commitment can benefit the whole supply chain.

In order to get more insights about the interaction between early order commitment and the parameters of the supply chain, we conduct some numerical results in the following Subsections.

### 3.2 Performance of Early Order Commitment

In this Subsection, we fix the parameters  $r=1$ ,  $L=l=10$ ,  $\rho=0.5$ , and vary  $A$  from 0 to  $L$  and calculate the corresponding relative cost increase or decrease for the retailer, the manufacturer, and the whole supply chain according to (19), (20) and (23). The corresponding relative cost increase or decrease are plotted in Figure 1. From this example, we can see that the earlier the retailer commit orders with the manufacturer, the more benefits can be achieved for the total supply chain. When  $A$  reaches the largest value (10 periods), the retailer's cost is increased by 43.92%, the manufacturer's cost is reduced by 69.85%, and the whole supply chain's cost is reduced by 15.30%.

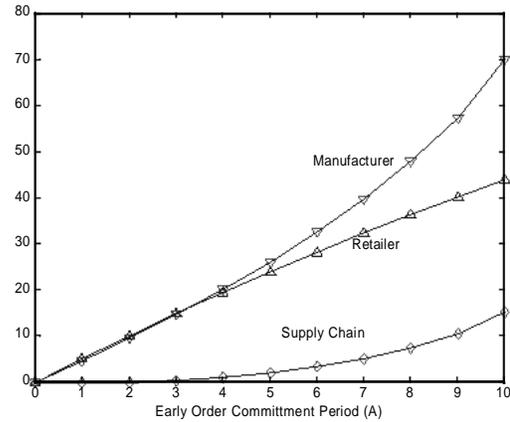


Figure 1. Performance of early order commitment period ( $r=1$ ,  $L=l=10$ ,  $\rho=0.5$ )

### 3.3 Impact of Demand Process Characteristics

In this Subsection, we first fix the parameters  $r=1$ ,  $L=l=10$  and vary  $\rho$  from  $-0.9$  to  $+0.9$  with increment 0.1. For each value of  $\rho$ , we vary  $A$  from 0 to  $L$  and calculate the corresponding relative cost increase or decrease for the retailer, the manufacturer, and the whole supply chain according to (19), (20) and (23). Then the value of  $A$  that results in the largest cost saving for the whole supply chain according to (23) is recorded as  $A^*$ , the optimal early order commitment period. We find that the optimal value of  $A^* = L=10$  periods under all the values of  $\rho$  for this setting. The corresponding relative cost increase or decrease are plotted in Figure 2. From the figure, we can see that the retailer's cost increases quickly as  $\rho$  increases to 0.5 or above. However, it shows that the cost savings for the manufacturer and the whole supply chain is about 70% and 15% respectively, and the results are relatively stable under different values of  $\rho$ .

However, there are interactions between  $A$ ,  $\rho$  and the leadtimes  $L$ ,  $l$ . Figure 3 represents the results for fixed parameters  $r=1$ ,  $L=10$ ,  $l=3$ . Similarly, we vary  $\rho$  from  $-0.9$  to  $+0.9$  with increment 0.1, and for each value of  $\rho$ , we vary  $A$  from 0 to  $L$  to find  $A^*$  the optimal early order commitment period. We find that the optimal value of  $A^*$  equals ten periods ( $A=L=10$ ) when  $\rho$  is not over 0.7, and  $A^*$

$=0$  periods when  $\rho$  is larger than 0.8. From the figure, we can see that the retailer's cost increase due to early order commitment climbs to extremely higher value as  $\rho$  increases, and finally exceeds the cost savings of the manufacturer. Under the cases where  $\rho$  is smaller than 0.5, the cost savings of the manufacturer and of the whole supply chain are about 70% and 10%, respectively.

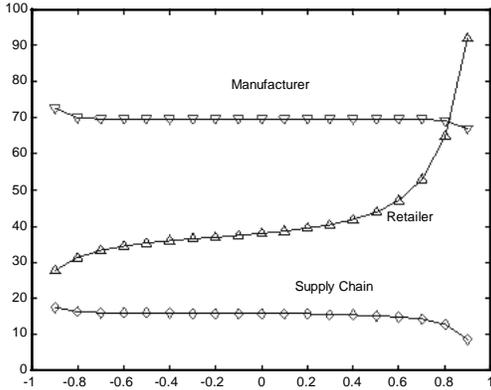


Figure 2. The impact of demand correlation ( $r=1, L=l=10$ )

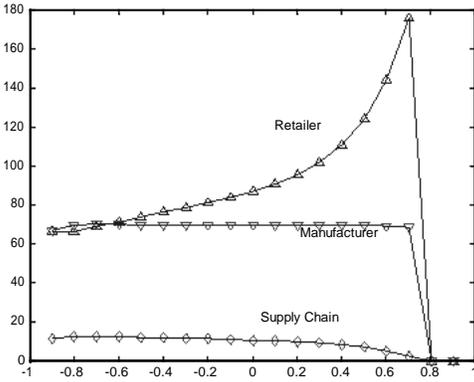


Figure 3. The impact of demand correlation ( $r=1, L=10, l=3$ )

### 3.4 Impact of Leadtimes

In this Subsection, we first fix the parameters  $r=1, \rho=0.5, L=10$  and vary  $l$  from 0 to 20. For each value of  $l$ , we vary  $A$  from 0 to  $L$  to find  $A^*$ , the optimal early order commitment period. We find that  $A^*=L=10$  periods when  $l$  is greater than or equals to 2, and  $A^*=0$  when  $l$  is very small (0 or 1). The corresponding relative cost increase or cost decrease is plotted in Figure 4.

Now we fix the parameters  $r=1, \rho=0.5, l=10$  and vary  $L$  from 0 to 20. For each value of  $L$ , we vary  $A$  from 0 to  $L$  to find  $A^*$ , the optimal early order commitment period. We find that  $A^*=L$  periods for all values of  $L$ . The corresponding relative cost increase or cost decrease is plotted in Figure 5.

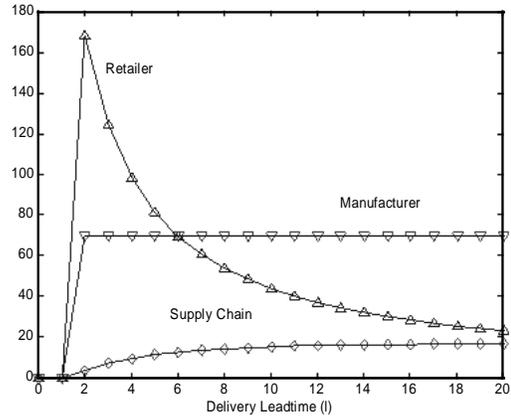


Figure 4. The impact of Delivery Leadtime ( $r=1, \rho=0.5, L=10$ )

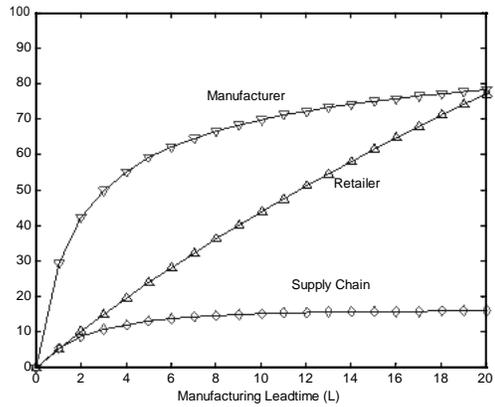


Figure 5. The impact of Manufacturing Leadtime ( $r=1, \rho=0.5, l=10$ )

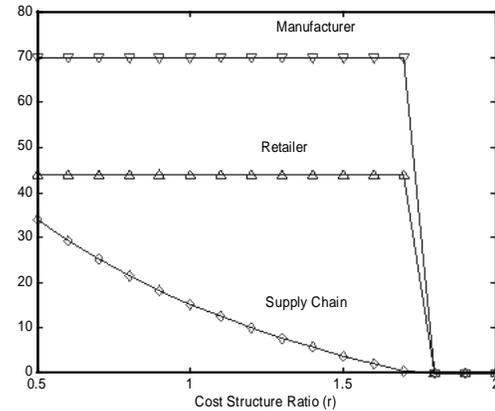


Figure 6. The impact of Cost Structure Ratio ( $\rho=0.5, L=l=10$ )

### 3.5 Impact of Cost Structures Ratio

In this Subsection, we fix the parameters  $\rho=0.5, L=l=10$  and vary  $r$  from 0.5 to 2.0 with increment 0.1. For each value of  $r$ , we vary  $A$  from 0 to  $L$  to find  $A^*$ , the optimal

early order commitment period. We find that  $A^*=L=10$  periods when  $r$  is smaller than or equals to 1.7, and  $A^*=0$  when  $r$  is relatively large (over 1.8). The corresponding relative cost increase or decrease are plotted in Figure 6. Obviously, the cost savings decrease as  $r$  increases.

#### 4. Conclusions

In this paper, an analytical model is developed that quantifies the impact of early order commitment on the performance of a simple two-level supply chain consisting of a single manufacturer and a single retailer. The model reveals that the effect of early order commitment depends on some key factors such as the cost structure of the supply chain, the lengths of manufacturing and delivery lead times, and the correlation of the demand over time. This model can be used to evaluate the benefit of early order commitment, to determine the optimal early commitment periods of the supply chain, and to estimate the maximum incentives the manufacturer can provide to encourage the retailer to commit its orders in advance.

#### References

- [1] Cachon and Fisher, "Supply chain inventory management and the value of shared information". *Management Sciences*, Aug. 2000.
- [2] Chen F., J.K. Ryan, D. Simchi-Levi, "The impact of exponential smoothing forecasts on the bullwhip effect" *Naval Research Logistics*, 2000, 47, 269-286.
- [3] Chen F., Drezner, Ryan, Simchi-Levi, "Quantifying Bullwhip effect in a simple supply chain: the impact of forecasting, lead times, and information", *Management Sciences*, March 2000.
- [4] Cvsu V., Gilbert S.M. Strategic commitment versus postponement in a two-tier supply chain. *European Journal of Operational Research*, 2002, 141, 526-543.
- [5] Gilbert and Ballou "Supply Chain benefits from advanced customer commitments", *Journal of Operations Management*, 1999.
- [6] Lee H., So, Tang, "The value of information sharing in a 2-level supply chain", *Management Science*, May 2000, 626-643.
- [7] Raghunathan S. "Information sharing in a supply chain: a note on its value when demand is non-stationary", *Management Science*, April 2001, 605-610.
- [8] Xu K, Y Dong, PT Evers "Towards better coordination of the supply chain", *Transportation Research Part E (Logistics)*, 2001, 35-54.
- [9] Zhao X., Xie J. and Zhang W.J. The Impact of Information Sharing and Ordering Co-ordination on Supply Chain Performance. *Supply Chain Management: An International Journal*, 2002, 7(1), 24-40.
- [10] Zhao X., Xie J., Lau R. Improving the Supply Chain Performance: Use of Forecasting Models versus Early Order Commitments, *International Journal of Production Research*, 2001, 39(17), 3923-3939.
- [11] Zhao X., Xie J., Wei J.C. The Impact of Forecast Errors on Early Order Commitment in a Supply Chain. *Decision Sciences*, 2002, 33(2), 251-280.

# Multiple Objective Planning for Production and Distribution Model of Supply Chain: Case of Bicycle Manufacturer

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## Abstract

Under increasing globalization, enterprises view supply chains (SC) as an integration of process control and management. The bicycle industry is one of the competitive industries in Taiwan, for which there is a complete supply chain system. To internationalize and improve the competitive advantage of this industry, it is necessary for it to improve the capacity of global production and distribution. In this paper, we consider both the maximum profit of enterprises and the maximum quality of customer service, using five programming methods to construct multi-objective production and distribution models. These five methods are: compromise programming, fuzzy multi-objective programming, weighted multi-objective programming, weighted fuzzy multi-objective programming and two-phase fuzzy multi-objective programming. The results reveal that the weighted multi-objective model was better for considering the maximum profit of enterprises and the maximum quality of customer service. Finally, we use the weighted multi-objective model for sensitivity analysis. These results show that after raising the per-unit production cost in production processes, the total profit would decrease. In addition, if the unit inventory cost increases due to improving the customer service level, then the total profit might increase, but not significantly. Furthermore, the shortage cost seems have interactive behavior on the enterprises, in which an increase of inventory cost will lower shortage cost.

Keywords: supply chain, bicycle industry, fuzzy multi-objective programming

## 1. Introduction

Due to the trend of globalization, the supply chain is increasingly important for many enterprises as one of the flow process controls and levels of management to be integrated. Ranging from the supply of raw materials, production, distribution, retail sales, and after-sales service to consumers, the primary objectives are to lower the total costs of production along the supply chain, and to increase production efficiency. With positive efforts from both government and industry, Taiwan has been admitted into the World Trade Organization (WTO) on January 1, 2001. Within the context of WTO, manufacturers are confronted with global competition, the need to accelerate the flow of materials and information. As a result, the development of an effective supply chain is essential for an industry to become successful.

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The bicycle industry, generally considered as conventional industry, demands massive labor capital investment. With its development over the last fifty years, the industry supply chain has complete up-, middle-, and down-stream manufacturers, making Taiwan one of the significant bicycle manufacturing centers of the world. In 1980, the amount of bicycles sold overseas ranked first world-wide, surpassing that of Japan. Nevertheless, although bicycles are not a high-tech product they do follow trends of fashion, creativity and diversity of product, go speed of supply has become critical to compete in the face of saturated markets, supply greater than demand, and the diversified demands of consumers. Therefore, this study aims to strengthen the capabilities of global management, to expand the core system of this industry into a global supply and demand chain, to provide timely production and high service quality, enhancing the competitiveness of these on the international market.

As Taiwan's bicycle industry is exposed to international competition, bicycle manufacturers must develop global management abilities to confront this new situation. As a result, this study considers multiple objective production and distribution, focusing on Taiwan's conventional bicycle manufacturing industry, considering enterprise profit and customer service level for multi-objective programming to develop a production and distribution model for bicycle manufacturers in Taiwan.

Here, five multi-objective programming methods have been adopted for comparison: multi-objective compromise programming, fuzzy multi-objective programming, weighted multi-objective programming, weighted fuzzy multi-objective programming, and two-phase fuzzy multi-objective programming. These five methods have used to compare in resolution for this model. Finally, weighted multi-objective programming has been used to conduct sensitivity analysis in order to obtain outcomes that manufacturers can use for reference in developing their supply chains. The results show that when increasing the per unit production cost in production processes, the total profit would decrease. If the unit inventory cost increase for improving the service level of customer, the total profit might increase, but not significantly. Furthermore, shortage cost seems have an

interactive behavior on the enterprises, and increased inventory cost will lower the shortage cost.

The remainder of this paper is organized as follows. In Section 2 previous literature is presented. In Section 3 a model for the bicycle supply chain is established. In Section 4 an example for applying this model to the bicycle supply chain is presented. Finally conclusions and recommendations are provided.

## 2. Previous Literature on Supply Chain and Multi-objective Programming for Production and Distribution

Since this study explores the issues of production and distribution of bicycle manufacturing, which is related to management operation and industrial supply chain, we first review previous literature on supply chain management. Then, we present studies on multi-objective programming, compromise programming, fuzzy multi-objective programming, weighted multi-objective programming, and two-phase fuzzy multi-objective programming, since they are issues of production and distribution of bicycle manufacturing.

### 2.1 Relevant literatures of supply chain

Chandra and Fisher (1994) dealt with the production and delivery of a single factory with single production in multiple periods. Comparing the separation and integration models of production and transportation problems, they found that the integration model of production and delivery can help to lower total costs. Nagata et al. (1995) examined the production and transportation problems of multiple products and multiple factories in multiple periods, using multi-objective and fuzzy multi-objective model for programming. There the programming problem for multiple periods included obtaining uncertain information when considering a management plan so as to construct a reasonable multi-objective production and transportation model. Tzeng et al. (1996) addressed the needs of practical issues, using fuzzy bi-criteria multi-index linear programming to deal with uncertain supply and demand environments in face of the coal procurement and delivery schedule for the Taiwan Power Company (TPC). This kind of problem has multiple destinations, multiple kinds of goals, and multiple kinds of shipping vessels. Petrovic et al (1998, 1999), used fuzzy models and simulation for the supply chain, and developed a decision-making system for an uncertain environment. Thus, they determined the inventory level and the order amounts with the supply chain model to simulate operation control with limited time and reasonable cost. Van Der Vorst et al. (1998) considered that supply chain management should include lowering or limiting uncertainty, so that the integral benefits of the supply chain could be improved. Sources of uncertainty include the following: vertical order prediction, information input, administration management, decision-making procedures, and innate uncertainty. This study used the food chain as example to improve the structure of allocation and operation management.

Although many factors of uncertainty were eliminated in that illustration, results indicated that the reasonable benefit of supply chain management has also been determined. Dhaenens-Flipo (2000) proposed clustering problems of production and transportation of multiple products from multiple factories for integrated programming. To deal with sophisticated problems with spatial decomposition he changed them into sub-problems, and employed the resolution method for vehicle routing problem (VRP), which also helped simplify the problem and lower total costs.

To sum up, when this current study considers the maximization of both enterprise profit and customer service level, the resolution can also be obtained from developing a multi-objective programming model in view of global supply chain system. The proposed model is described in the following section.

### 2.2 Multi-objective and fuzzy multi-objective programming

Zeleny (1982) pointed out that there is nothing about decision making in programming when there is only one single objective, as decision making is already endowed in the estimation of the objective function value coefficient. Thus, when the objective function coefficient is determined the decision maker can only accept or discard the outcome resolved by the model, and no other information can ever be obtained from the model by the decision maker. As can be seen, the development of "multi-objective programming" was brought about by the incomplete consideration taking account of only one single objective, as well as the fact that the decision maker can either accept or discard the optimal solution presented. In contrast, the objective of multi-objective programming is mainly to find a feasible non-inferior solution set or compromise solution so that the decision maker can effectively focus on the trade-offs when several objectives are in conflict. This is generally indicated as follows:

$$\begin{aligned} \max/\min f &= [f_1(x), f_2(x), \dots, f_k(x)] \\ \text{s.t. } Ax &\leq b \\ x &\geq 0 \end{aligned} \quad (1)$$

where,  $b = [b_1, b_2, \dots, b_m]$ ;  $x = [x_1, x_2, \dots, x_n]$ ;  $A = A_{m \times n}$

#### (1) Multi-Objective Compromise Programming

First, the ideal solution is defined as indicating the optimal value  $f_i^*(x) = \sup\{C^k x | x \in X\}$ ;  $i = 1, \dots, k$  in the feasible solution domain  $X$  of every single objective,  $f_k(x)$ . Of them, Then, based upon the spirit of compromise programming, and according to the aforementioned definition of distance scale, we have to locate a point so that it has the shortest distance to the ideal solution from the non-inferior solution set, which can be written as:

$$\begin{aligned} \min d_p \\ \text{s.t. } x \in X \end{aligned} \quad (2)$$

where

$$d_p = \sum_{i=1}^k \left( |f_i^*(x) - f_i(x)| \right)^{\frac{1}{p}}; 1 \leq p < \infty$$

In the above mentioned equation, the distance scale  $d_p$  varies with different values of  $p$  and has diverse meanings (Yu 1985, and as seen in Appendix I).

Hwang and Yoon (1981) claimed that it is necessary to consider the closest positive ideal solution (PIS) and the farthest negative ideal solution (NIS), so that the greatest profit can be obtained and the greatest risk avoided during decision making (see Appendix (II)).

### (2) Weighted Multi-Objective Programming

According to the multi-objective linear programming problem, as put forward by Martinson (1993), the two separate models of fuzzy multi-objective and multi-objective compromise programming can be used. The easiest way to deal with this issue is to settle the weight values of each objective by the preferences of the decision makers.

If the weighted value of each objective  $w_i$ , then the resolution for the compromise programming of the multi-objective programming can be found as follows:

$$\begin{aligned} \min d \\ \text{s.t. } \frac{w_i}{w_i} \frac{f_i^*(x) - f_i(x)}{f_i^*(x) - f_i^-(x)} \leq d, i = 1, \dots, k \\ Ax \geq b \\ x \geq 0 \end{aligned} \quad (3)$$

### (3) Fuzzy Multi-Objective Programming

Bellman and Zadeh (1970) applied the notion of fuzzy sets for decision making theory, considering conflicts between constraint equation and objective equation of the general programming, and proposed the max-min operation method in order to determine the optimal decision of the two solutions. Furthermore, Tanaka et al. (1974) advanced fuzzy mathematics programming (FMP), which resulted in the widespread application of fuzzy mathematical programming on several practical levels.

Zimmermann first introduced fuzzy set theory into the conventional linear programming problem in 1976, and combined the fuzzy linear programming model with multi-objective programming into fuzzy multi-objective linear programming (Zimmermann, 1978). The fuzzy linear programming employed in this study uses the max-min-operation method, which turns multiple objectives into a single one. The procedures of the operation are as follows: initially, the upper bound and lower bound limits of each objective and constraint equation are determined; then membership function are

constructed and membership function of the decision making is set; and finally, multiple objectives are turned into one single objective for resolution (details as found in Appendix (III)).

### (4) Weighted Fuzzy Multi-Objective Programming

The membership function of the weighted fuzzy linear programming can be indicated as follows:

$$\mu_D(x^*) = \max \min \{w_i \mu_{G_i}(x^*), i = 1, \dots, k\} \quad (4)$$

Making multiple objectives into a single objective for resolution, this problem can finally be transformed into the following exact LP problem for resolution:

$$\begin{aligned} \max \lambda \\ \text{s.t. } \frac{1}{w_i} \frac{f_i(x) - f_i^-(x)}{f_i^*(x) - f_i^-(x)} \geq \lambda, i = 1, \dots, k \\ Ax \geq b \\ x \geq 0 \end{aligned} \quad (5)$$

### (5) Two-Phase Fuzzy Multi-Objective Programming

Lee and Li (1993) put forward two-phase fuzzy multi-objective programming in order to deal with the defects of non-compensatory solutions in the linear fuzzy objective programming by Zimmermann. In their two-phase fuzzy multi-objective programming, the fuzzy linear programming by Zimmermann was used to determine the non-compensatory solution (Phase I), and then the greatest average fuzzy membership function (Phase II) of an individual objective among objectives is employed once the non-compensatory solution is found. It has also been substantiated that the multi-objective solution obtained from the two-phase fuzzy multi-objective programming is a compensatory solution for raising the achieved level, and the steps of resolution are as follows:

#### (1) Phase I

Locate the non-compensatory solution  $(x^{(1)})$  of Zimmermann's fuzzy linear programming.

#### (2) Phase II

$$\begin{aligned} \max \bar{\lambda} = \frac{1}{k} \sum_{i=1}^k \lambda_i \\ \text{s.t. } \frac{f_i(x) - f_i^-(x)}{f_i^*(x) - f_i^-(x)} \geq \lambda_i \geq \lambda^{(1)}, i = 1, 2, \dots, k \\ Ax \geq b \\ x \geq 0 \end{aligned} \quad (6)$$

This study uses the five kinds of multi-objective programming methods mentioned above to resolve and compare the supply chain model construct below. It also compares and analyzes these results, and conducts sensitivity analysis using one of the models for a real case.

### 3. Model Establishment For the Bicycle Supply Chain

The research on supply chains in this study mainly investigates the production and distribution problems confronted by the bicycle manufacturer. Based on a review of previous research, the production and distribution of bicycles are explored to establish two objective models for manufacturers profit and service level.

#### 3.1 The establishment and basic assumption of model

Generally, the goal of enterprise management is to obtain maximum profit. However, both manufacturing and service industries have gradually turned to an orientation of consumer service to develop stability, and because consumer service can provide a competitive advantage for enterprises in the market. As a result, this paper furthermore incorporated the idea of improved consumer service into its design. This helps provide space for flexible adjustment in order to consolidate sources of clientele, while enterprises can produce to respond to demand, rather than simply following rigid production schedules. Ultimately, favorable consumer service for stable clientele can be provided with such a design.

This study, based on the characteristics of bicycle industry, used the following assumptions (see Figure 1):

1. Concrete material flow processes of bicycle are simplified as: input of raw material – inventory of raw material --- product – inventory of product --- distribution; and this study focuses only on the model structure of production – inventory of product – distribution;
2. For bicycle manufacturers, this study considers the problems of production and distribution for multiple periods and multiple products as demands vary because of factors such as the international economy, weather, etc;
3. Since demand for this product will vary due to factors such as weather, the season, or holidays; a one year time period within the research period is marked as the planning period, and this planning period is divided into four separate parts, conforming to the annual seasons.
4. The industrial strategy of the industry has already employed BTO once an order is received; therefore, it is assumed that product demand is already known;
5. Only a single transportation system 'land-sea' is considered.

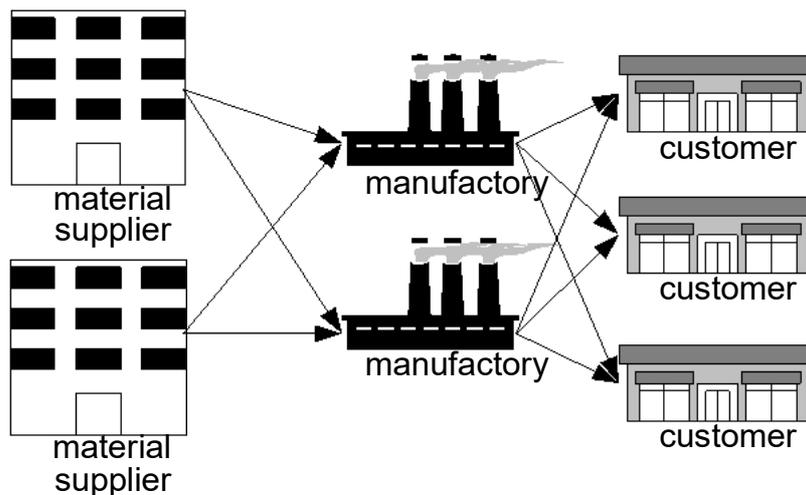


Figure 1 Research Domain

#### 3.2 Designation of Parameters and Variables

- $p_{kt}$  : Selling price of product k at period t;
- $d_{jkt}$  : Estimated demand of product k at period t in the locality j;
- $\alpha_{ijkt}$  : Unit delivering cost of product k at period t from manufacturer i to the point of demand j;
- $\beta_{ikt}$  : Unit production cost of product k at period t in manufacturer i during ordinary working hours;
- $\gamma_{ikt}$  : Unit production cost of product k at period t in manufacturer i during overtime working hours;

- $\delta_{ikt}$  : Unit inventory cost of product k at period t in manufacturer i;
- $\delta_{jkt}$  : Unit shortage cost of product k during period t at the locality of demand j;
- $a_{ikt}$  : The consumption amount of the needed material r for producing per product k at period t in manufacturer i;
- $f_{irt}$  : The upper bound value of the useable material r at period t in manufacturer i;
- $b_{kt}$  : The production time needed for producing per product k at period t in manufacturer i;
- $\eta_{it}$  : The upper bound value of ordinary working hours at period t in manufacturer i;

- $c_{it}$  : The upper bound value of overtime working hours at period  $t$  in manufactory  $i$ ;
- $h_{ikt}$  : The minimal safety inventory for product  $k$  at period  $t$  in manufactory  $i$ ;
- $\theta_{it}$  : The upper bound value of safety inventory at period  $t$  in manufactory  $i$ ;
- $x_{ikt}$  : The production amount of product  $k$  at period  $t$  in manufactory  $i$  during ordinary working hours;
- $\omega_{ikt}$  : The production amount during overtime working hours for product  $k$  at period  $t$  in manufactory  $i$ ;
- $y_{ijkt}$  : The amount of product  $k$  delivered at period  $t$  in manufactory  $i$  to the locality of demand  $j$ ;
- $e_{ikt}$  : The inventory of product  $k$  at period  $t$  in manufactory  $i$ ;
- $s_{jkt}$  : The shortage amount of product  $k$  during period  $t$  at the locality of demand  $j$ .

### 3.3 Model objective

#### (1) Maximize total profit

To pursue the maximum profit is one of the business objectives and equation (7) helps maximizing the total profits. Profit itself includes items such as revenue and cost, while cost embraces production cost (including both ordinary and overtime working hours), transportation cost, inventory cost, and shortage cost.

Max total profit = (revenue – production cost during ordinary working hours – production cost during overtime working hours – transportation cost for product – inventory cost of product – shortage cost of product)

$$\begin{aligned} \text{Max } z_0 = & \sum_{i=1}^T \sum_{k=1}^K \sum_{j=1}^m \alpha_{ijkt} y_{ijkt} - \sum_{i=1}^m \beta_{ikt} x_{ikt} + \sum_{i=1}^m \gamma_{ikt} \omega_{ikt} \\ & + \sum_{i=1}^m \sum_{j=1}^n \alpha_{ijkt} y_{ijkt} + \sum_{i=1}^m \epsilon_{ikt} e_{ikt} + \sum_{j=1}^n \delta_{jkt} s_{jkt} \end{aligned} \quad (7)$$

#### (2) Maximize the level of service in each period

Under the assumed state that both the production time and transportation time of per unit product are fixed, a portion of the production time is used as the flexible time-space for adjusting to demand changes in order to satisfy the customers' service needs. With this flexible period of time (spare production time in every period/total amount of time available for production in every period) as the crucial factor affecting the level of service, the assumption of relationship between the two can be indicated by the following formula.

Level of service  $l = f(\text{spare production time in every period/total amount of time available for production in every period})$

$$\begin{aligned} \text{Max } \zeta = & f(W_t), \quad t = 1, 2, \dots, T \\ \text{s.t. } & W_t = 1 - \frac{\sum_{i=1}^m \sum_{k=1}^K b_{ikt} x_{ikt} + \sum_{i=1}^m \sum_{k=1}^K b_{ikt} \omega_{ikt}}{(\eta_{it} + c_{it})} \end{aligned} \quad (8)$$

If the manufacturer is confronted with defects such as

instability of demand and supply or mismanagement, it could provide delayed product delivery. And if the value of  $W_t$  is high, that indicates that there are many facilities idle inside the factory to meet the urgent needs of customers: although a quality product could be generated there would be a low turnover. As a result, a trade-off relationship is created between the two objective equations, (13) and (14), in this study.

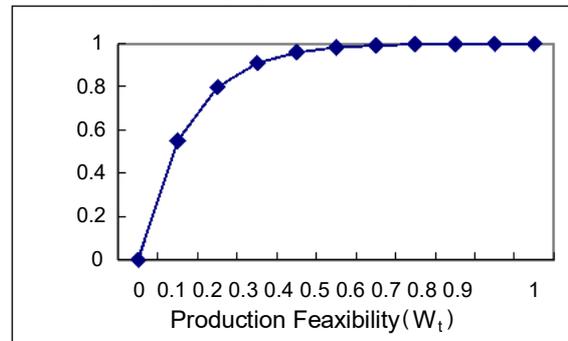


Figure 2 Relationship between Service Level of Manufacturer and Production Feasibility in  $t$  period

### 3.4 Model constraints

#### (1) Raw material Constraint

Raw material needed for production < amount of raw material provided

$$\sum_{k=1}^K a_{krt} (x_{ikt} + \omega_{ikt}) \leq f_{irt} \quad (9)$$

$$i = 1, \dots, m; r = 1, \dots, R; t = 1, \dots, T$$

#### (2) Productivity Constraint

Since a manufacturer is constrained by plant and equipment, it is limited to a certain maximum production capability. And this study uses the bases production time as its unit.

Normal working hours X time needed for production with per unit normal working hours < maximal productivity during normal working hours

Overtime working hours X time needed for production with per unit overtime working hours < maximal productivity during overtime working hours

$$\sum_{k=1}^K b_{ikt} x_{ikt} \leq \eta_{it}; \quad i = 1, \dots, m; t = 1, \dots, T \quad (10)$$

$$\sum_{k=1}^K b_{ikt} \omega_{ikt} \leq c_{it}; \quad i = 1, \dots, m; t = 1, \dots, T \quad (11)$$

#### (3) Inventory constraint

Due to the constraint of space for inventory, it is essential that the total amount of product inventory in every period must be smaller than the limit of maximal inventory capacity. Furthermore, the product inventory this period should be equal to the total amount of inventory for the last period and amount for this period, subtracted by the amount distributed.

Amount of inventory product < maximal capacity of inventory

Amount of inventory this period = inventory capacity of the last period + production amount this period – amount of product distributed.

$$\sum_{k=1}^K e_{ikt} \leq \theta_{it}; i = 1, \dots, m; t = 1, \dots, T \quad (12)$$

$$e_{ikt} = e_{ik(t-1)} + (x_{ikt} + \omega_{ikt}) - \sum_{j=1}^n y_{ijkt} \quad (13)$$

$$i = 1, \dots, m; k = 1, \dots, K; t = 1, \dots, T$$

#### (4) Relationship between the amount of product distribution and demand

The actual amount of product distributed has to be smaller or equivalent to the demands, as predicted in each locality, while the difference between the amount of distribution and demand will be the amount of shortage.

Amount of product distributed ≤ Estimated amount of demand

Shortage product = Amount of Product needed – Amount of Product distributed

$$\sum_{j=1}^n y_{ijkt} \leq d_{jkt}; j = 1, \dots, n; k = 1, \dots, K; t = 1, \dots, T \quad (14)$$

$$s_{jkt} = d_{jkt} - \sum_{i=1}^m y_{ijkt}; j = 1, \dots, n; k = 1, \dots, K; t = 1, \dots, T \quad (15)$$

#### (5) Non-negative constraint

$$x_{ikt} \geq 0; i = 1, \dots, m; k = 1, \dots, K; t = 1, \dots, T \quad (16)$$

$$\omega_{ikt} \geq 0; i = 1, \dots, m; k = 1, \dots, K; t = 1, \dots, T \quad (17)$$

$$y_{ijkt} \geq 0; j = 1, \dots, n; k = 1, \dots, K; t = 1, \dots, T \quad (18)$$

$$e_{ikt} \geq 0; i = 1, \dots, m; k = 1, \dots, K; t = 1, \dots, T \quad (19)$$

### 4. Illustrative Example: Bicycle Manufacturer

In this section the real case of a bicycle manufacturer in Taiwan is examined to demonstrate that this model can be effectively well planned for providing good idea and thinking to treat supply-chain problems. The latest data for the management scenarios were obtained and that manufacturer data was put into this model, whereas each of the information is obtained as modified from the actual data. Section 4.1 provides the problem description and designation for the model; Section 4.2 shows the results and analysis of the operation; and Section 4.3 is sensitivity analysis and discussion.

#### 4.1 Problem description and definitions

The operation problem of this practical example is designed to have three points of supply and seven points of demand, and the period of production programming is divided into four periods in each year. As learned from the case interviews, the demand for bicycle products varies seasonally, furthermore, bicycle has employed season as its different departments as different view-points from other high-tech products having high time cost and depreciation cost. As a result, in this study the first to the

fourth seasons are, respectively, July to September, October to December, January to March of the next year, and April to June. Since this study concerns only bicycles without power, the seven types of products used for product programming are mountain bikes, aluminum alloy bikes, light-weight bikes, children's bikes, sport bikes, racing bikes, and carbon fiber bikes. The working hours of the manufacturing plant are designated as the six ordinary working days per week with twenty-four hours per day. Based upon the already known productivity of the three points of supply, it takes an average of thirty to forty hours to assemble a bicycle, and productivity constraint is rendered during the ordinary working hours in every season. The overtime working hours of the plant is the working hours in holidays.

#### 4.2 Results and analysis

The operation in this part includes: (1) multi-objective compromise programming solution (MOCP), (2) weighted multi-objective programming solution (WMOP), (3) fuzzy multi-objective programming solution (FMOP), (4) weighted fuzzy multi-objective programming solution (WFMOP), (5) two-phase fuzzy multi-objective programming solution (TPFMOP). The results obtained are indicated in Tables 2 and 3.

Table 2 Multi-objective Programming Solution

Model	MOCP	WMOP*	FMOP	WFMOP*	TPFMOP
Total profit (N.T.\$*1000)	31038	456411	31133	493296	310925
1 <sup>st</sup> period	0.93	0.92	0.93	0.89	0.93
2 <sup>st</sup> period	0.95	0.93	0.95	0.89	0.95
3 <sup>st</sup> period	0.79	0.68	0.79	0.58	0.79
4 <sup>st</sup> period	0.88	0.87	0.88	0.76	0.88

\*weights:4:1:1:1:1

As can be seen from Table 2, the value of the total profit by the weighted multi-objective model is far larger than the profit from the multi-objective compromise model, and it is the same for the service level for all periods. The magnitude of value change of the service level in the fourth period as programmed in the fifth model is rather limited, indicating there is more stable service quality, it is thus understood that the multi-objective weight obtained depends largely on the importance with which decision maker endows objectives. Furthermore, the size of the weighted value will have to be adjusted according the nature of the particular problem.

Comparing the results of fuzzy multi-objective, weighted fuzzy multi-objective, and two-phase fuzzy multi-objective programming, the maximum of the total profit value is from weighted multi-objective programming; and comparing this to a single objective, the maximization of the profit will be about the same. The objective value of the service level in each of the programming periods in the weighted fuzzy multi-objective model are similar to the programmed results of the profit maximization of a single objective. It

can thus be said that the model has almost lost its multiphase analyzed, the objective of the two-phase fuzzy objective significance. Since the programmed results of multi-objective programming – its resultant value – would be somewhat smaller than that of fuzzy multi-objective programming, while the achievement of the service level of total achievement in the two-phase multi-objective programming is larger by 0.001, with an insignificant level of improvement.

Table 3 Cost Analyses of the Multi-objective Programming Model

Model		MOCP		WMOCP*		FMOP		WFMOP*		TPFMOP	
Outcome**		Cost-Profit	%								
Total profit		2571618	-	2662507	-	2570337	-	2720545	-	2570034	-
Total cost		2261231	-	2237054	-	2259001	-	2227248	-	2259109	-
Production cost (ordinary)	Material cost	1568831	0.69	1655888	0.74	1610677	0.71	1684356	0.76	1610528	0.71
	Manufacturing cost	221504	0.10	227610	0.10	231246	0.10	229880	0.10	231149	0.10
Production cost (overtime)	Material cost	42474	0.02	0	0	0	0.00	0	0.00	0	0.00
	Manufacturing cost	12565	0.01	0	0	0	0.00	0	0.00	0	0.00
Transportation cost	Tax cost	212911	0.09	234169	0.10	212999	0.09	245300	0.11	213110	0.09
	Ocean shipping cost	53630	0.02	61130	0.03	53535	0.02	67288	0.03	53471	0.02
Inventory cost		388	0.00	220	0	336	0.00	424	0.00	339	0.00
Stoket cost		148927	0.07	58038	0.03	150208	0.07	0	0.00	150511	0.07

\*weights: 4:1:1:1:1; \*\*Unit: hundreds N.

Comparing the results of the above-mentioned models in Table 3, it can be seen that material cost is the highest item of manufacturing cost for bicycles in terms of the total production cost, amounting to almost 70%; next is, the manufacturing cost, which amounts to 11% of the production cost. Thus, the production cost of this industry comprises 81% of the total cost, which shows that this industry is labor-intensive with high material cost. Despite the fact that the bicycle production has already been internationalized, and that its manufacturing, distribution, and selling behaviors are also multi-national, however, analysis of its costs indicates that it is not a high-tech product with high timing cost. Therefore, it is usually distributed by sea freight since that is inexpensive and the ratio of its cost to the total cost is almost negligible. However, the cost of custom can reach 10% of the total cost, amounting to the third highest cost item. As a result, the most important factor for the product sales of bicycle is the in-plant manufacturing cost and material cost of bicycle production, followed by export costs from the country of the manufacturing plant and the import taxes at the locality of demand. Of these three cost items, material cost is beyond the control of the bicycle manufacturer, so manufacturing cost and import and export taxes affect where the manufacturing plant is located.

After having compared multi-objective compromise model to two-phase fuzzy multi-objective programming, the difference of objectives between multi-objective compromise model and weighted multi-objective model programming are rather large, although, the objective

value of profit in multi-objective compromise is low. Even though the service level in each period of the weighted multi-objective model is not as high as that of the multi-objective compromise model, the programmed results of service level from 1<sup>st</sup> to 4<sup>th</sup> period of the weighted multi-objective model, with the exception of 3<sup>rd</sup> period (the service level of the 3<sup>rd</sup> period is about 0.7), are all well over 0.8. In addition, the programmed results of fuzzy multi-objective model and two-phase fuzzy multi-objective model are much the same. However, the outcome of the weighted fuzzy multi-objective programmed model differs insignificantly from the programmed resolution of a single objective. Consequently, if the decision makers, having analyzed the results of each model, wish to achieve the programmed results of multi-objective production and distribution with maximum profit and highest quality service, using the weighted multi-objective model would be more compatible with these results.

#### 4.3 Sensitivity analysis

Based on the conclusions above, the weighted multi-objective programming model is used to conduct the sensitivity analysis for the following policy. This policy is designed in three separate parts: (1) changes of unit production cost (manufacturing cost is increased by 20%, 40%, 60%, 80%, 100%); (2) changes of unit inventory cost (inventory cost is increased by 20%, 40%, 60%); (3) changes of unit shortage cost (shortage cost is lowered by 20%, increased by 20%, 40%).

Table 4 Results of Changes to Unit Manufacturing Cost

Objective	Total profit (N.T.\$*1000)	Level of service			
		1 <sup>st</sup> period	2 <sup>st</sup> period	3 <sup>st</sup> period	4 <sup>st</sup> period
Present situation	425453	0.90	0.92	0.69	0.82
Increase 20%	387295	0.90	0.91	0.70	0.83
Variation	-0.090	0.00	-0.01	0.01	0.01
Increase 40%	347342	0.90	0.91	0.69	0.82
Variation	-0.184	0.00	-0.01	0.00	0.00
Increase 60%	307922	0.89	0.90	0.69	0.82
Variation	-0.276	-0.01	-0.02	0.00	0.00
Increase 80%	269729	0.89	0.90	0.68	0.82
Variation	-0.366	-0.01	-0.02	-0.01	0.00
Increase 100%	233360	0.89	0.90	0.68	0.81
Variation	-0.452	-0.01	-0.02	-0.01	-0.01

Table 5 Results of Changes to Unit Inventory Cost

Objective	Total profit (N.T.\$*1000)	Level of service			
		1 <sup>st</sup> period	2 <sup>st</sup> period	3 <sup>st</sup> period	4 <sup>st</sup> period
Present situation	425453	0.90	0.92	0.69	0.82
Increase 20%	426902	0.90	0.91	0.70	0.83
Variation	0.003	0.00	-0.01	0.01	0.01
Increase 40%	426919	0.90	0.91	0.70	0.83
Variation	0.003	0.00	-0.01	0.01	0.01
Increase 60%	427384	0.90	0.91	0.70	0.83
Variation	0.005	0.00	-0.01	0.01	0.01

Table 6 Results of Changes to Unit Shortage Cost

Objective	Total profit (N.T.\$*1000)	Level of service			
		1 <sup>st</sup> period	2 <sup>st</sup> period	3 <sup>st</sup> period	4 <sup>st</sup> period
Present situation	425453	0.90	0.92	0.69	0.82
Increase 20%	430538	0.90	0.91	0.71	0.84
Variation	0.012	0.00	-0.01	0.02	0.02
Increase 40%	424601	0.89	0.91	0.69	0.82
Variation	-0.002	-0.01	-0.01	0.00	0.00
Increase 60%	424562	0.89	0.90	0.69	0.82
Variation	-0.002	-0.01	-0.02	0.00	0.00

- (1) Changes of production cost: As can be seen from Table 4, the increase of production cost can impact the objective value of each objective in this study. With every increment of 20% to the manufacturing cost, the total profit would be lowered by approximately 9%. However, production cost has much less impact on the service level of each period.
- (2) Changes of inventory cost: As indicated from Table 5, after inventory cost is increased by 20%, 40%, and 60% it will, on the contrary, increase both the total profits and the service levels in the 3<sup>rd</sup> and 4<sup>th</sup> periods.
- (3) Changes of shortage cost: As seen in Table 6, the changes to shortage cost will have insignificant impacts on the five objectives studied in this research

because we have considered the feasible time-space unit production cost, unit inventory cost, unit shortage cost for adjusting the demand change. cost are increased. However, an increase of inventory cost

To sum up the analyses above, it is found that if the will increase the total profit, while shortage costs have an insignificant impact on the total profit. If all three of these unit production cost increases, total profit will be reduced. In contrast, an increase of unit inventory cost will cause unit cost items are increased, that will lead to a decrease in total profit to rise, although unit shortage cost has no the shortage cost and increase in the partial inventory cost, impact on total profit. On the other hand, the increase of indicating that shortage quantity will be lowered because these three unit cost items will lead to the decrease of cost, so inventory quantity should be increased to meet shortage cost and the increase of partial inventory cost, demand. Results of the kind show that inventory cost and indicating that shortage cost will be reduced as of cost, so shortage cost seem have interactive behavior on that inventory will be increased to meet the demand. This enterprises, in which the increase of inventory cost will result shows that the inventory cost and shortage cost lower shortage cost. seem to have interactive behavior on the enterprise, whereas the enhancement of inventory cost will reduce shortage cost.

## 5 Conclusions and recommendations

### 5.1 Conclusions

Currently, most of the Taiwan bicycle manufacturers are OEM plants, so enhancement of service level has been one of their goals. In addition, both manufacturing and service industries are gradually induced to be customer service-oriented since stable customer service helps enterprise survival. As a result, this study uses the notion that production elasticity as partial spared productivity is more favorable than full production. This allows for demand space for adjustment to customer elasticity, and it increases the quality of customer service. Although such practice would lower enterprise profit because there is a trade-off relationship between these two objectives, this study uses multi-objective programming to meat this system.

This study uses five kinds of multi-objective programming methods for resolutions: multi-objective compromise programming, fuzzy multi-objective programming, weighted multi-objective programming, weighted multi-objective fuzzy programming, and two-phase fuzzy multi-objective programming. Comparing these five kinds of programming, it is found that the result from weighted multi-objective programming could be well received by the decision maker. The results of this are as follows:

Production cost is the highest of all the total cost items for bicycle production, amounting to 81%, which indicates that bicycle production is a labor-intensive and high material cost manufacturing industry. Besides, although bicycle manufacturing has multi-national production, distribution, and sales; its cost of time is relatively unimportant compared to that of high-tech industries. Thus its distribution is done by sea freight, whose cost is almost insignificant in terms of the total cost. However, expert and import taxes are the third highest cost item. Therefore, the greatest factor that affects the production and distribution of this industry would be the material cost of the product and manufacturing cost of the plant, followed by the export tax of the country where the manufacturing plant is located and the import tax at the locality of demand.

It is found that the total profit will be lowered when

### 5.2 Recommendations

Recommendations offered in this study for subsequent research:

- (1) Although this study has considered the service level of the manufacturer, assumptions were used for the function relationship between service level and production elasticity factor. Nevertheless, there are too many factors that affect the service level of manufacturer, so subsequent studies could focus on them for further investigation.
- (2) In the planning model of this study, it is necessary to appreciate the weight relationship among each of the objectives; thus the preferences of the decision maker are extremely important.
- (3) For practical management, the transaction price and manufacturing cost are not linear; transaction behavior allows discount and differential pricing, whereas manufacturing cost requires a factor as economic scale, in order to make the model realistic. In this study, there is further investigation on the problem of import and export, whose factors of influence are rather widespread and which is also one of the important issues in enterprise management.
- (4) The fuzzy multi-objective programming employed in this study is simply a fuzzy objective equation, and fuzzy constraint equations can be added in subsequent studies.
- (5) This model has only considered the issues of production and distribution, while upper-stream part supply is considered to be already known. Thus, relevant variables of changes from the upper-stream manufacturing supplier are been considered; if these could be considered, the model would be even more comprehensive.

## Appendix

- (1) According to the explanation in Yu (1985),<sup>20</sup> should be used when the decision maker is focused on a certain objective. However,  $d_1$  is recommended when a balance of the objectives is required. The distance scale  $d_p$  found in the above-mentioned equation can also be standardized as follows:

$$d_{p=1} = \max_i \left| \sum_{i=1}^k \frac{f_i^*(x) - f_i(x)}{f_i^*(x)} \right|; i = 1, 2, \dots, k$$

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$$d_{p=\infty} = \max_i \left| \frac{f_i^*(x) - f_i(x)}{f_i^*(x)} \right|; i = 1, 2, \dots, k$$

(II)

Considering the shortest distance to the positive ideal solution (PIS) and the farthest distance from the negative ideal solution (NIS),  $d_p$  can be indicated as follows:

$$d_p = \left| \sum_{i=1}^k \left| \frac{f_i^*(x) - f_i(x)}{f_i^*(x) - f_i^-(x)} \right|^p \right|^{\frac{1}{p}}$$

where,  $f_i^-(x) = \min_{x \in X} \{f_i(x)\}$ , while  $x^i$  is the solution relative to  $f_i^*(x)$ . Generally speaking,  $f_i^-(x)$  is a negative ideal solution.

(III)

(a) Determination of the ceiling and bottom limit of each of the objectives and constraint equations.

If it is assumed that the decision maker has the most satisfactory and ideal ceiling limit value  $f_i^*(x)$  and the bottom limit value  $f_i^-(x)$  toward the  $i$ th objective  $f_i^-(x)$ , then the decision maker can decide the values of the ceiling and bottom limit according to individual preference. Or the decision maker can take such objective as the function of the feasible solution space and find out the values through calculation, which is as shown in the payoff table.

(b) Establishment of membership function

The membership function toward the  $i$ th fuzzy objective is as follows:

$$\mu_G(x) = \begin{cases} 0 & f_i(x) \leq f_i^-(x) \\ \frac{f_i(x) - f_i^-(x)}{f_i^*(x) - f_i^-(x)} & f_i^-(x) \leq f_i(x) \leq f_i^*(x) \\ 1 & f_i(x) \geq f_i^*(x) \end{cases}$$

as shown in Figure A.

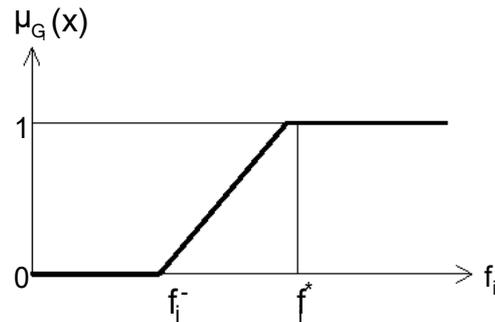


Figure A Membership Function of the Objective

(c) Set up the membership function for the decision making set  $\mu_D(x)$

$$\mu_D(x^*) = \min_{i,j} \{ \mu_{G_i}(x), i = 1, \dots, k \}$$

From the max-min operation equation, the feasible fuzzy set can be found at the intersection of the objective and constraint equation. Since the decision maker needs precise decision-making recommendations, the maximum value of the membership in this decision making set is required. As a result, the maximum is utilized, and the corresponding membership function is thus obtained.

$$\mu_D(x^*) = \max \{ \min \{ \mu_{G_i}(x^*), i = 1, \dots, k \} \}$$

$$\geq \max \{ \min \{ \mu_{G_i}(x), i = 1, \dots, k \} \}$$

(d) Turn the multiple objectives into a single objective for resolution

Finally, this problem can be transformed into precise LP problem for resolution:

$$\begin{aligned} & \max \lambda \\ & \text{s.t. } \frac{f_i(x) - f_i^-(x)}{f_i^*(x) - f_i^-(x)} \geq \lambda, i = 1, \dots, k \\ & Ax \leq b \\ & x \geq 0 \end{aligned}$$

Thus, general linear programming can be used for resolution.

## References

- [1] Bellman, R.E. and Zadeh, L.A. (1970), "Decision making in a fuzzy environment", Management Science 17B(3), 141-164.
- [2] Chandra, P. and Fisher M.L. (1994), "Coordination of production and distribution planning", European Journal of Operational Research 72 (3), 503-517.
- [3] Dhaenens-Flipo, C. (2000), "Spatial decomposition for a multi-facility production and distribution problem", International Journal of Production

- Economics 64(1-3), 177-186.
- [4] Hwung, C.L. and Yoon, K. (1981), Multiple attribute decision making: methods and applications: a state-of-the-art-survey, Springer-Verlag.
- [5] Lee, E.S. and Li, R.J. (1993), "Fuzzy multiple objective programming and compromise programming with Pareto optimum", *Fuzzy Sets and Systems* 53(2), 275-288.
- [6] Martinson, F.K. (1993), "Fuzzy vs. minmax weighted multiobjective linear programming illustrative comparisons", *Decision Sciences* 24(4), 809-824.
- [7] Nagata, M., Yamaguchi, T. and Komo, Y. (1995), "An Interactive method for multi-period multiobjective production-transportation programming problems with fuzzy coefficients", *Journal of Japan Society for Fuzzy Theory and Systems* 7(1), 153-163.
- [8] Petrovic, D., Roy, R. and Petrovic, R. (1998), "Modelling and simulation of a supply chain in an uncertain environment", *European Journal of Operational Research* 109(2), 299-309.
- [9] Petrovic, D., Roy, R. and Petrovic, R. (1999), "Supply chain modeling using fuzzy sets", *International Journal of Production Economics* 59(3), 443-453.
- [10] Tanaka, H., Okuda, T. and Asai, K. (1974), "On fuzzy mathematical programming", *Journal Of Cybernetics* 3(1), 37-46.
- [11] Tzeng, G.H., Teodorovic, D. and Hwang, M.J. (1996), "Fuzzy bi-criteria multi-Index transportation problem for coal allocation planning of Taipower", *European Journal of Operational Research* 95(1), 62-72.
- [12] Van Der Vorst, J. G. A. J., Beulens, A. J. M., De Wit, W. and Van Beek, P. (1998), "Supply chain management in food chains: improving performance by reducing uncertainty", *International Transactions in Operational Research* 5(6), 487-499.
- [13] Yu, P.L. (1973) "A class of solutions for group decision problems. *Management Science*", 19(8), 936-946.
- [14] Yu, P.L. (1985), Multiple-criteria decision making: concepts, techniques, and extensions, Plenum, New York.
- [15] Zeleny, M. (1982), *Multiple Criteria Decision Making*, McGraw-Hill, New York.
- [16] Zimmermann, H.J. (1978), "Fuzzy programming and linear programming with several objective functions", *Fuzzy Sets and Systems* 1(1), 45-55.

# E-Supply Chain Integration for Inter-Enterprise Business Practices

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## Abstract

Traditional business partnerships are changing in response to technology advancements and business innovations. Many companies have already reengineered their internal processes, and now the focus has shifted to their trading partners. With network connectivity, supply chain integration is the core strategic competence that enables many companies to act as one. A supply chain represents the cross-functional integration of activities that cross the borders of individual companies. This feature is very important in many industries, because many firms must collaborate intensively throughout a project lifecycle. The issues involved in selecting e-supply chain partners extend beyond choosing a trading partner or a contractor and must include configuring the business-to-business inter-enterprise processes among partners. In the future, supply chains, rather than enterprises will compete with each other. There will be no isolated islands of automation, and the future of business applications will support inter-enterprise collaborative commerce (C-Commerce). The c-commerce e-supply chain scheme enables a dynamic “virtual team” to fulfill many mission-critical business processes throughout a project lifecycle will undoubtedly be the best business solution for the new millennium.

## 1. The Emerging Strategic Alliance

Increasing global competitiveness and the advancement of information technology are potent drivers for organizations to alter their business strategies. Companies need to adapt a new type of agile and responsive organizational structure to fit into the global spectrum of business. New market players in today's e-economy gain diverse skills of workers through alliances, and a flat managerial hierarchy enables them to collaborate on a virtual basis that produces flexible products to meet customers' needs. This places the global economy as a whole in a continual restructuring mode, putting pressure on every industry. The situation is intensified by rapid advances in Information Technology (IT), which have drastically shortened the adaptation periods for organizational changes that used to be comparatively long. Hammer (1990) suggested that enterprises use IT to reengineer their existing business processes to achieve strategic outcomes and improve competitiveness [1], and many companies have “reengineered” changes in their organizational structures, business functions, and business processes to achieve more agility, flexibility, and responsiveness in their operations. Reengineering is critical to an organization's

survival during certain periods when there are major economic upheavals that threaten the organization's existence, and many organizations that do not reinvent themselves are doomed to become part of business history. With the maturity of Internet technologies, organizations can readily perform certain business functions which go beyond organizational boundaries. E-commerce practices today have demonstrated the power of this “virtual organization”, which integrates business processes from the front office to the back office through the Internet.

Due to these paradigm shifts, the traditional business partnership scheme has changed, and the focus has now shifted to their business partners. Today, companies can achieve a business advantage by leveraging networking technology and the principles of supply chain integration. With network connectivity, supply chain integration is now the core strategic competence that enables many companies to act as one. This feature is very important for every industry, because many firms need to cooperate/collaborate intensively throughout a project lifecycle. Today, every industry is an information-intensive industry. Information and communication have always played a major role in their competitiveness and growth. In the future, the supply chains, rather than the enterprises (designer, manufacturer, and supplier) themselves, will compete with each other. An increase in horizontal integration synchronizes the output of the entire supply chain. There will be no isolated islands of automation [2], and those who best define and reengineer their business processes in the e-supply chain partnership will likely be the most successful in this industry.

## 2. The Fusion of E-Business

Although e-business is sometimes confused with e-commerce, it is widely accepted that e-commerce is the buying or selling of products, goods, information, and services over the Internet, whereas e-business is a complex fusion of business processes, enterprise applications, and organizational structure necessary to create a new high performance business model. The topic of e-business often includes business-to-business process automation. Some examples are procurement (bidding, and outsourcing), selling (production and supply chain management), ordering (shipping and logistics), billing, and payment. These processes, by definition, almost always go beyond enterprise boundaries, and there are many other e-business service environments where Internet technologies are being utilized by end users, enterprises, and other parties that wish to do business over the net. Structures changes caused by these shift

impacted the boundaries of the enterprises. Indeed, without transition to an e-business foundation, e-commerce cannot be executed effectively, and no e-business will be truly effective without interacting with all of its supply chain partners in an automated fashion.

### 2.1 The Customer-Centric Supply Chain Management

While technology is at the heart of the change that is revolutionizing our economic life, successful e-business is concerned with building new kinds of relationships with customers, employees, business partners, and all other participants in business life. These relationships are termed the supply chain. Supply Chain Management (SCM) evolved several decades ago from a set of logistics performance tools to an inter-enterprise, and even channel-wide, operating philosophy. The growing dependence on the supply chain has been emphasized by the following changes to traditional business practices: (a) the growth of information sharing between vendors and customers, (b) the paradigm shift in the marketplace from the mass-production of standardized products to flexible operations providing customized/personalized products that customers are demanding solutions designed to meet their specific needs, (c) the rise of process-oriented team efforts replacing traditional departmental functions, and (d) increased trend on inter-enterprise processing and outsourcing. All of these features are very important to today's industries, because many firms need to collaborate intensively throughout a project life cycle and the project team needs continuous access to business plans as the project proceeds.

### 2.2 Supply Chain Collaboration and Integration

The supply chain involves procurement, enterprise resource planning (ERP), EAI (Enterprise Application Integration), inter-enterprise processing, schedule sharing, logistics, inventory management, feedbacks, quality management, and so forth. However, to be successful the members of the supply chain need to collaborate to help the organizations reduce cost, utilize resources more effectively, and improve relationships with their clients. The fundamental benefit of SCM is cooperation and collaboration among different stakeholders. The objectives and scope of work must be clearly stated and faithfully executed (Figure 1). Cooperation and collaboration are especially critical in the management of today's supply chain; these depend on the organizations' willingness to link their strategic objectives and fundamental business processes to create unique, seamless, enterprise-wide portal that are ready to serve their customers. These companies are also capable of quickly consolidating critical competencies and physical processes to gain competitive advantages.

Therefore, issues related to e-supply chain integration include the internal and external core business processes,

the development of close linkages between channel partners, and the management of production and information as they move across organizational boundaries. For example, the manufacturing process for materials or the production and distribution of equipment are transparent to all members in the supply chain. A supply chain is integrated in terms of people focused on processes that ultimately respond to customer demand, but its success requires technology that can integrate and support every exchange of information across the entire supply chain. Issues involved in selecting e-supply chain partners extend beyond choosing a trading partner or a contractor and must include configuring the business-to-business inter-enterprise processes among partners. The selection of processes and cooperation with supply chain partners are critical to the success of business.

### 3. Designing an e-Business Supply Chain Strategic Framework

In today's e-supply chain practices, all business data are transmitted over a variety of communication networks, and the essence of e-business is the communication of business data between organizations under a collaborative scheme in an entire supply chain. Data communication is critical for streamlining the entire supply chain business processes. However, the difficulty is that management has not yet examined these issues from any perspective other than the one dedicated by the paradigm of the field, nor is there much effort to target the issue of transforming e-business practices into an inter-enterprise collaboration supply chain scheme.

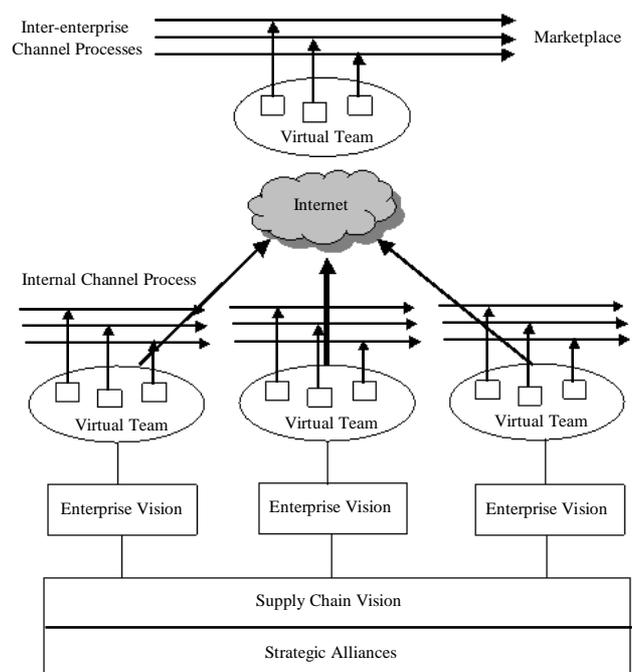


Figure 1. The Virtual Team in a Supply Chain Scheme

A typical project involves the coordination of multi-disciplinary work efforts by different organizations. Although participants may share a common goal of completing a project satisfactorily, their specific objectives are different and their degree of participation depends on their organizational strategies. Thus, the need for integration of trading partners—especially integration of the supply chain and managerial functions—becomes a strategic vision for the future of business practices in the e-business era, and the major parts of the supply chain inter-enterprise processing concepts are presented here.

### 3.1 The Value Chain

To design a supply chain solution, one must start by examining the basic framework of an enterprise's major business activities, which are considered competitive factors that are derived from Porter's value chain [3]. The value chain divides the organization into a set of generic functional areas, which can be further divided into a series of value activities. In the value chain, there are two distinct types of functional area: primary and support (Figure 2). Primary activities are concerned with the direct flow of production (such as inbound logistics, operations, outbound logistics, marketing, sales, and service), whereas support activities (firm infrastructure, human resource management, technology, and procurement) support the primary activities and each other. Starting with its generic value chain categories, a firm can subdivide into discrete activities, categorizing those activities that contribute best to its competitive advantage. Porter's version of supply chain management

is called a value chain because it focuses on value. The value is measured by the amount customers are willing to pay for an organization's product or service. Primary and support activities are called value activities, and an enterprise will be profitable as long as it creates more value than the cost of performing its value activities [4]. In this way, a value chain is defined and a better organizational structure and business process can be created around those value activities that can most improve an organization's competitive advantage [5].

Porter also recognized linkages outside the enterprise, as they relate to the customer's perception of value. This provides the possibility that one value chain could be linked to another value chain, because one business partner could be the other's customer. This interconnected value chain system can act as a supply chain that encompasses the modern business world, and participating organizations can readily extend their technologies to their partners. The "extended enterprise" aspect enables supply chain integration, more effective outsourcing, and self-service solutions for both internal and external stakeholders [5]. This extended enterprise allows for the sophisticated interweaving of online business processes across trading partners and with other internal and external information sources. The following section will illustrate a typical integrated e-supply chain solution for the inter-enterprise business practices.

### 3.2 The General Business Service

Based on a value chain analysis, several general base business activities are identified, and a series of

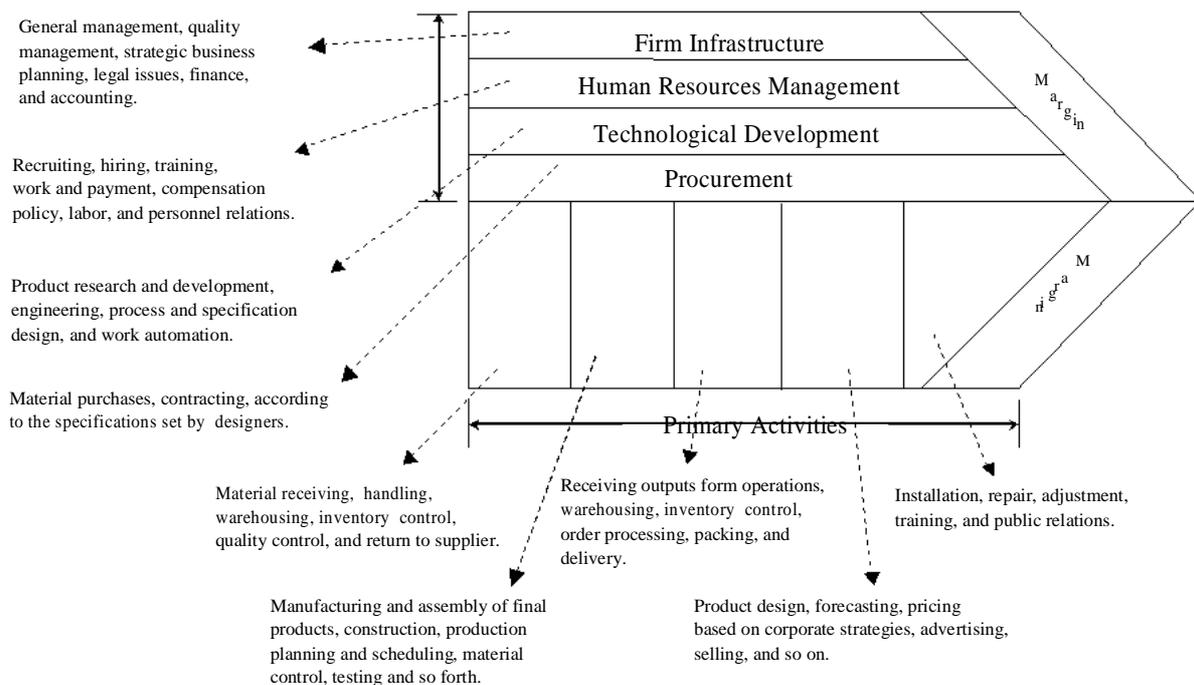


Figure 2 Porter's Value Chain and Value Activities

decomposing efforts will render more detailed sub-processes by using the object-oriented approach. On the other hand, effective management involves many managerial functions, such as scheduling, budgeting, quality control, resource management, and so forth. The ultimate purpose of these management functions is to allocate resources (manpower, equipment, material, etc.) and then monitor, control, and keep all processes on track during every stage of the project cycle. Many business management share many of the same business activities as derived from the value chain, because Porter's value chain activity is the backbone of every type of organization in every type of industry. In here, the Object-Oriented modeling of the transformation process for inter-enterprise processing is summarized in Figure 3.

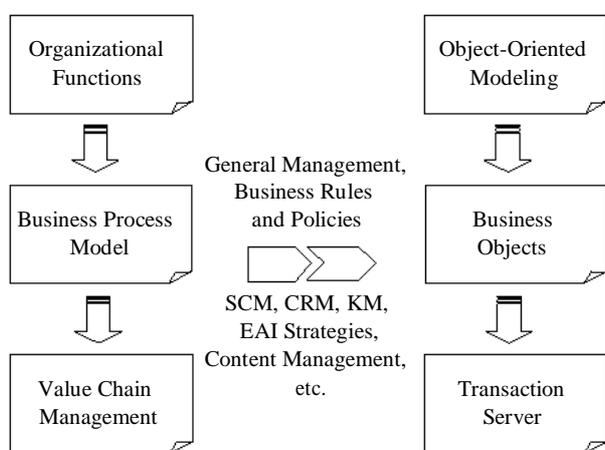


Figure 3 Transformation Process for Inter-enterprise Processing

### 3.3 The Object Orientation

In this study, an object-oriented approach is used to map the corporate business process with the information system in terms of a series of reusable business objects, which encapsulate complex business rules. Accordingly, (a) the tedious redesign efforts of information systems can be circumvented and the corporate information system can become very adaptive, (b) the applications can run on different platforms through network connectivity, and (c) this schematic business blueprint not only fits a given enterprise, but it can also be viewed as an open architecture that links to trading partners. From a process-oriented point of view, this blueprint allows many organizations to share the same business components (or database) in a network and to participate in the business practices of the strategic alliance supply chain. In contrast to an isolated IT system, this approach allows the organization business process to permeate different organizations, and communication in this system becomes process-to-process oriented.

The Unified Modeling Language (UML) is an object-oriented modeling technique that provides a

comprehensive methodology for designing object-oriented applications in a logical, structured manner, and it is available for the development of three-tier client/server distributed applications. A basic core set of diagrams (use case [6] models, interaction diagrams, class diagrams, and activity diagrams) is used in the development processes to refine the design and ultimately define the business objects, after which the class diagrams are coded and mapped into the organizational information system. By applying the object modeling methodology, these business component relationships can be transformed into object-based interactions.

### 3.4 Wielding the Solution

These tools and theories can now be combined to provide an inter-enterprise processing scheme for e-supply chain practices. The first step is to transform a functional organizational structure into a process-based structure based on the value chain model and business process reengineering. The second step is to use the UML to build an object view (Class Diagrams) of business operations that follows the organizational business rules, policies, and business process scenario (Figure 4). The third step is to translate the object-oriented blueprint of the enterprise processes model into machine recognizable codes that can be compiled into a series of reusable business objects.

Several programming languages (such as C++, Java, and Visual Basic) can be used in this transformation. The fourth step is to migrate these business objects into a transaction-processing system that has Internet/Intranet capability (for example, Microsoft Transaction server or the SAP R/3 Enterprise Resource Planning Transaction Server). The business objects can reside on the project team's information system and "talk" to each other using the Common Object Request Broker Architecture (CORBA) scheme to perform over the Internet certain business functions which go beyond organizational boundaries. Regardless of location, users can participate in team coordination/collaboration and share their "collective intelligence" within a virtual corporation. Figure 5 is a schematic diagram of a three-tier information system that stores business objects to perform certain tasks for the organization. This global information networking and inter-enterprise process offers enormous benefits to the many industries.

The business objects presented thus far depict business services, in that each represents an artifact that is encountered or produced in the daily business routine. Each module in the user services part of the model actually relates to a single use case statement, which, in code terms, would actually have to be divided into a number of distinct routines. These routines deal with the methods and properties of the business objects in the business services tier, and the user interface uses these objects to display needed information and feed user input into the system. The business objects, in turn, use objects in the data services layer to get their data. In this

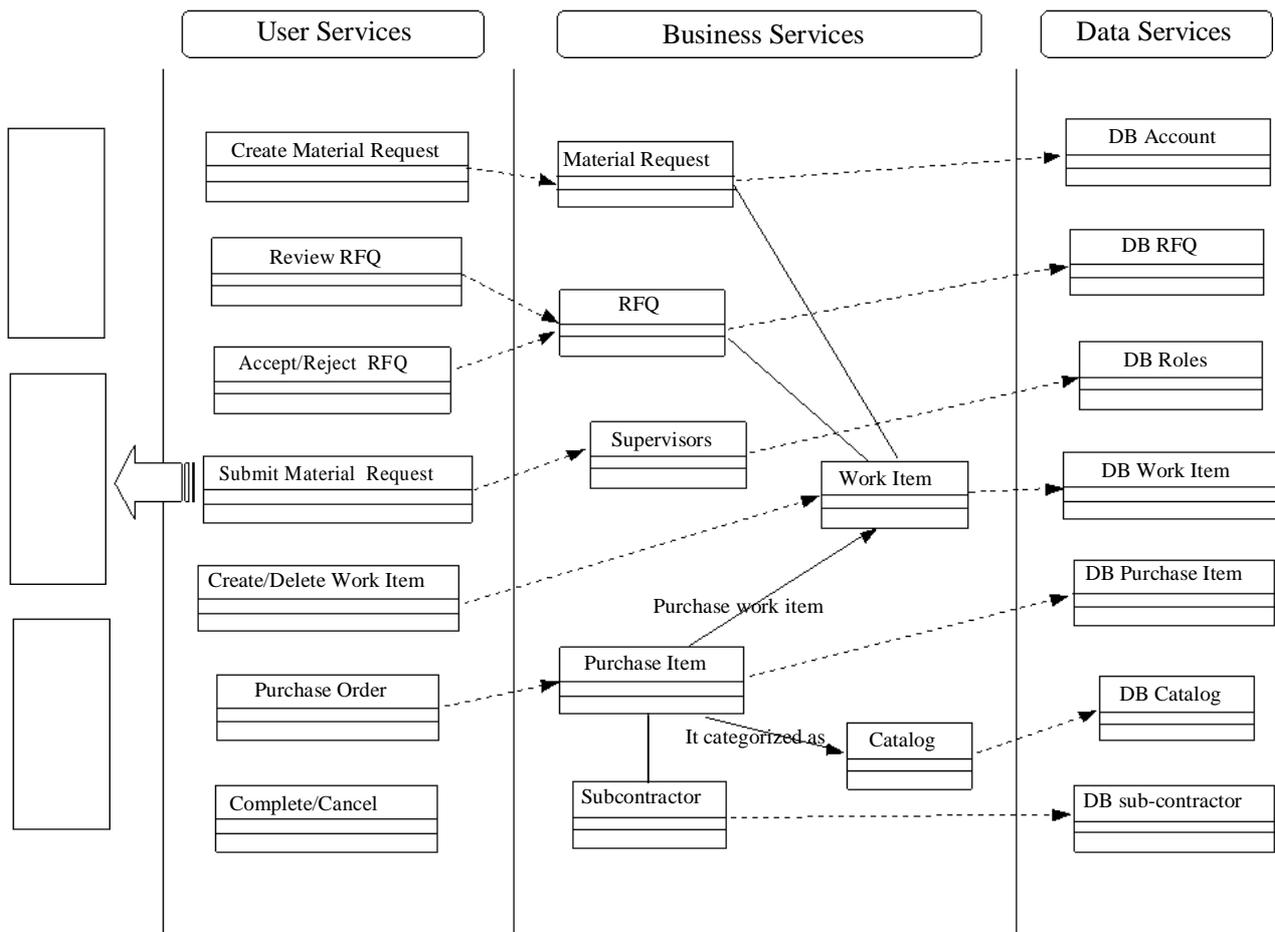


Figure 4 Object-Oriented of Typical Progress Payment in Three-Tier Service Approach

way the user interface could change without impacting the underlying way in which the application dealt with the business, and the database could be replaced with a new database without affecting the rest of the system. As long as the interface to the data service objects remains intact, the rest of the code will compile and run properly.

### 3.5 The E-Supply Chain Inter-Enterprise Application Integration

As mentioned previously, most business plans are unique, complex, extensive, expensive, and subject to tight schedules and budgets. The teams for any given project includes some combination of engineers, contractors, subcontractors, materials suppliers, equipment providers, and even inspectors, and thus the team will normally be different for each project. All of the complexities inherent to different project situations are an inherent part of business practices. As a consequence, managing a business project may require extensive interdisciplinary professional skills to achieve optimum performance. From the supply chain point of view, project members must collaborate to synchronize the output of the entire supply chain to fulfill a particular job. The project partnership in the supply chain becomes

a strategic alliance wherein contractors must align their business processes and information systems to support inter-enterprise processes and decision-making. Configuring business-to-business operations among trading partners is very important, because the supply chain represents the cross-functional integration of all activities that cross the borders of the participating organizations. The issues involved in selecting e-supply chain partners extend beyond choosing a trading partner or a contractor and must include the technological capability to configure the business-to-business collaboration among the partners. Using the value chain concept to identify an organization's competitive advantages and then reengineering its core business processes accordingly is the best way to make a company more process-aware, and that is the beginning of inter-enterprise processes.

E-business solutions should be built on an Internet computing architecture that leverages standard Internet communication protocols and company intranets, extranets, and the global Internet to provide low-cost and universal access to all members of the e-business supply chain. With new web technologies, such as XML, Internet-based systems can offer functionality and information to users through a standard Web browser,

thereby eliminating requirements for traditional Electronic Data Interchange (EDI) or client-based software and reducing IT implementation and maintenance costs, cycles, and burdens. The winners in the Internet economy will be those companies that can respond most rapidly and efficiently to the customer's demands. As a result, an e-business supply chain solution must provide support for the capture and communication of customer demand, as well as enable this demand to automatically trigger business events and initiate process workflow (such as launching manufacturing runs, starting business tasks, and issuing purchase requests within the enterprise and across the supply chain). This supply chain also needs a common data model, because to be effective an e-business supply chain solution will need to deliver an accurate and common view of customer demand data -- as well as any subsequent events, plans, or other business data. This new "e-supply chain" offers virtually unlimited business opportunities in the alignment of processes and technologies. A well-designed and well-integrated supply chain will improve upon existing cost-responsive processes and have organizational agility in the event of change.

#### 4. Conclusion

The challenges of the global marketplace are increasingly forcing today's process-centered organizations to utilize more fully the skills, knowledge, competencies, and resources found in their integrated supply chain networks. Parallel, rather than serial optimization is the key to supply chain management, and companies must acknowledge that adaptivity is increasing becoming a measure upon which its productivity will be evaluated. This adaptivity requires enhancing communication among all team members and aligning their actions toward a common project goal, and IT will be a key "enabler" for this transformation effort.

The explosion of strategic alliances and partnerships on a global scale has brought about the formation of inter-enterprise virtual organizations capable of leveraging the skills, physical resources, and innovative knowledge that reside at different locations in a supply chain network (Figure 6). This paper provides a broad discussion on the possible development of EAI scheme for inter-enterprise processes that embraces all aspect of business practices, and creates multi-channel and multi-technology solutions such as CRM, PRM in a fast-moving and technologically indefinite environment. In today's customer relation management, or selling chain management practices, the customer is in control, and a business must realign its value chain around the customer to eliminate

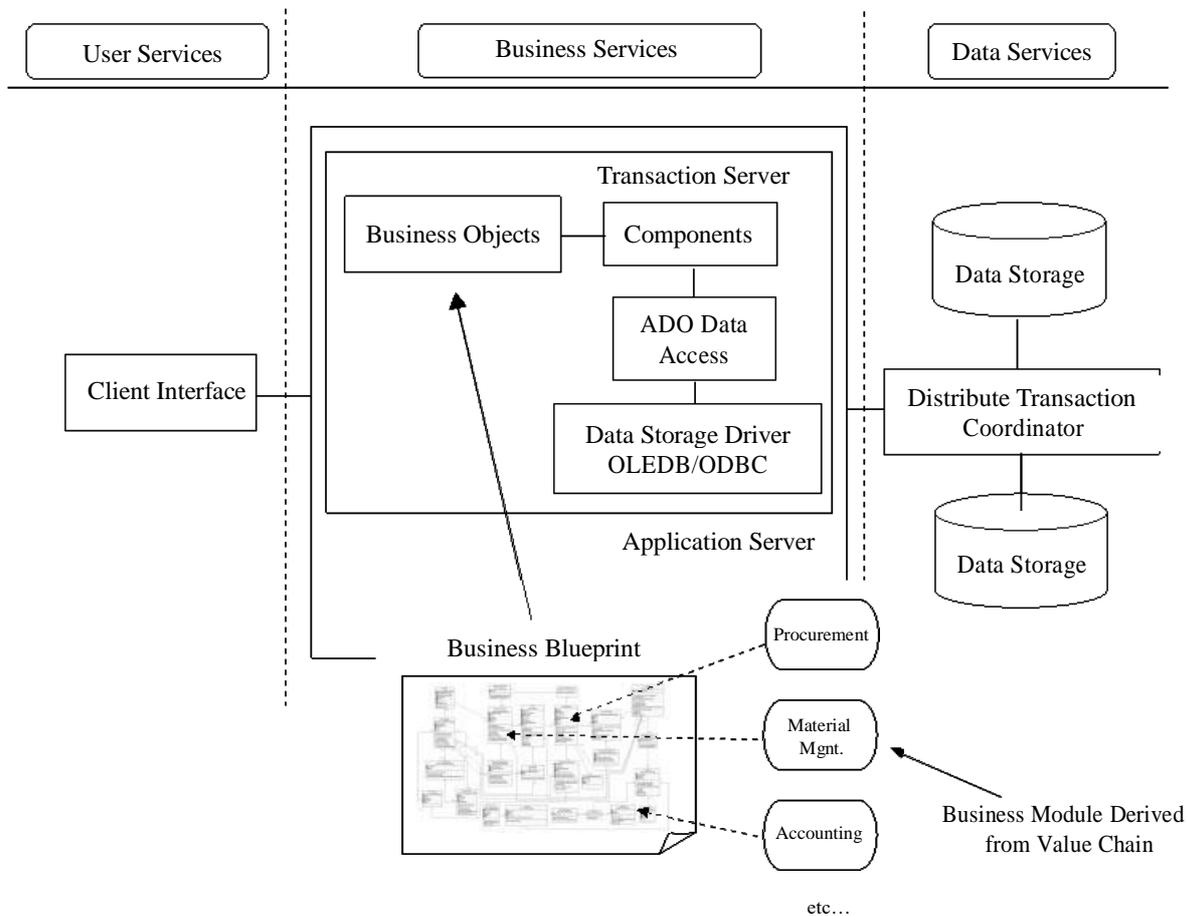


Figure 5 The Adaptive Business Information System

inefficiencies, and custom information, products, and services. Communication in the supply chain must be process-to-process oriented, and collaboration is the best way that trading partners can interact. Process integration across the supply chain becomes a new challenge for today's industries. Enterprises will need to learn that content communication is as important as technological infrastructure to the enterprise software application architecture. For example, the future mobile business will rely more heavily on content management than software application. Opportunity opens doors, but success requires walking through them. With a new focus on process and supply chain management, traditional business partnerships will have to redesign their business strategies. The Collaborative Commerce (CC) e-supply chain scheme that enables a dynamic "virtual team" to fulfill many mission-critical business processes throughout a project lifecycle will undoubtedly be the best business solution for the new millennium.

## Reference

- [1] Hammer, M. "Reengineering Work: Don't Automate, Obliterate." Harvard Business Review, pp. 104-112. Summer 1990.
- [2] Hannus, M., "Islands of Automation." <http://cic.vtt.fi/hannus/islands.html>, Technical Research Center of Finland, 1998.
- [3] Porter, M. "Competitive Advantage: Creating and Sustaining Superior Performance." The Free Press, 1985.
- [4] Kuglin, F. A. "Customer-Centered Supply Chain Management, A Link-by-Link Guide," AMACOM, a Division of American Management Association. 1998.
- [5] Curran, T. A. Ladd, A., and Keller, G. "SAP R/3 Business Blueprint, Understanding Enterprise Supply Chain Management," Prentice Hall, Inc. 2000.
- [6] Jacobson, I., "Using Objects to Develop Your Business & IT Support-The Use Case Driven Approach." SIGS Object Expo Conference, 1994.

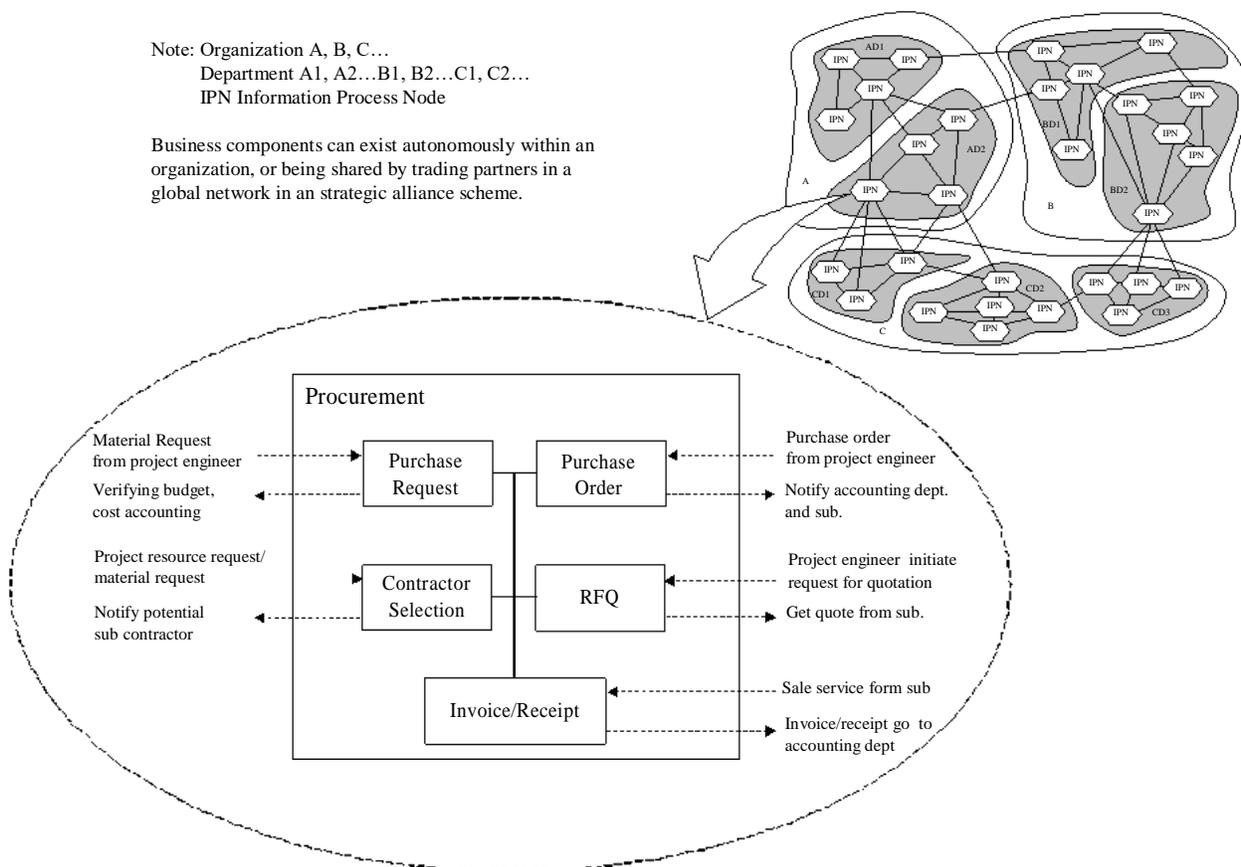


Figure 6 Share Component Inter-enterprise Processing

# **The Integration of the Third Party Information Resources: The Informationalization Breakthrough for Enterprises Based on the Star Supply Chain Management**

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## **Abstract**

With the development and application of the technology of computer, network and telecom, the informationalization has become the significant guarantee for enterprises to realize the continuous development and strengthen the marketing competitive power. Now, how to make full use of information remains a hot issue for the enterprises. A new idea of the third party external resources integration is brought up here. Setting up a star-supply chain with the core of the third party information resources integration enterprise helps to solve the problem of sharing information resources among enterprises, and promote economic globalization.

## **1. Introduction**

With the development of the quick steps for the global economics and the fast popularity of the network, a lot of changes have taken place in the circumstance of global trade and fierce competition. In the next round of the economic competition, we could see that, developed countries will strengthen the enterprise competitive power by applying information technology as a main lever and weapon, constantly cut the cost of products on the value chain, reduce the period, improve the efficiency and the product additional value, thus strengthening the economic energy and the developing power. On the increment chain which helps to create the value chain, the relationships between the supplier, producer, distributor, customer and the interrelated benefit groups are strengthened; and the social value trend which keeps changing influences the decision-making and operation of enterprises.

Under such kind of background, the traditional pattern is broken, and it is impossible for the enterprises to gain long-term profits through single batch manufacturing or on a large scale. The interaction and influences between enterprise and enterprise, enterprise and supplier, enterprise and customer, and enterprise and other groups is much more stronger. And the times of great change, from isolated manufacture to collaboration operation, from independent development to cooperation, has arrived. And it results in the direction and evolvement of informationalization.

## **2. The connotation of informationalization**

The informationalization means that the enterprises utilize information technology in every tache of production and management, explore and take advantage of the internal and external information resources and human resources sufficiently, and set up a corresponding organizational pattern, in order to realize the automation of production, the network of the management and intelligence of the decision-making support, improving the efficiency, level and benefits of the production, management and decision-making, and strengthen the competitive power of enterprises.

In the market economy, informationalization mainly lies in the fact that in pursuit of fastness, novelty, endurance, low costs and efficiency, the enterprises, as the principal part of marketing competition, employ the information of modern technology and communications technology in the process of daily operation and management. The advantage of it is that it can span over the boundaries of the information gathering and sharing sections, fields and industries, break through the restraints of time and space, promote the transformation of enterprise management and the innovation of technology and knowledge, integrate and optimize the resources of the enterprises, including human resources, materials, capital, etc, and as a result, make the enterprises' competitive advantage more prominent.

The informationalization of an enterprise is a complex course, covering a wide field. It may be divided into two parts—the internal informationalization and the external informationalization of an enterprise.

### **2.1 The integration of the intranet and the home information for an enterprise**

The integration of internal information means to realize the informationalization of basic management, research, and development. The foremost task for the integration of internal information is to realize the management computerization, share of the information, rational decision-making and wholeness of management. In another word, realizing linking such taches as management, research, development, production, equipment, supply, sales, transportation and service, realizing the resource optimization of human, capital, materials, and technology by means of computer management software under advanced management idea,

such as MRP, MRP II, ERP, etc, thus helping the decision-making more rational for each department on the basis of the internal shared information, and lowering the marketing risk.

## 2.2 The exploitation and analysis of the extranet and the external information for an enterprise

The external informationalization means that through the exploitation and analysis of the external information, the enterprises make use of the information resources to guide and influence the internal activities of the enterprises. In the days of fierce competition, how to utilize the external resource is a very important issue for enterprises. By the enforcement of supply chain management and client resource management among enterprises, strengthen the relationship of enterprises, suppliers and distributors; take great advantage of the information resource of great quantity and quality from home and abroad, keeping track of the product technology and market trend, and ensuring the superiority of knowing the market changes timely, and of strengthening the ability against risk.

The internal informationalization is the basis of the external informationalization, and only by combining these two parts can we create an integration of the clients and their partners, therefore benefiting from the external informationalization, operating the enterprise systematically, helping the enterprise cut down the operation cost, exploring the market and attract the clients, and supplying the clients with satisfactory service. The exploitation of the external information is the prerequisite of the supply chain integration from the internal to external, and only on the basis of a sufficient exploitation of external resources can an enterprise truly make use of the advanced idea of supply chain management(SCM).

## 3. The actuality of enterprises' informationalization

With the arrival of new economy, the enterprises are trying hard on the informationalization, and have made outstanding progress, which represents in the following two ways:

### 3.1 The internal resource integration develops rapidly

In view of software resource, most enterprises have set up modernized system of production management and working, and the software resource they have mainly focuses on some fundamental software, such as operation system, system maintenance software, office automation software and finance software. On one side, enterprises select useful information from various information sources through modern technology, and set up large-scaled database of high density in order to store a large amount of original information and useful information; on the other hand, enterprises promote the management and operation by robots and computers in production, assembly and storage, which helps the products be yielded according to the right time and right quantity, and be delivered to the

clients in time. At the same time, automation is realized on office system by combining computer and modern telecom technology, and terminal equipment is set up on every position, which strengthens the efficiency and accuracy of information. Nowadays, many large-scaled and medium-scaled enterprises have elementarily realized the internal informationalization, which means they have purchased a certain amount of ERP software, made the internal resources integrated to some degree, and realized the internal management computerization, etc.

In the part of network construction, as the internal and external information of an enterprise piles up and up and competition information ranks especially high in the enterprise activities, more and more enterprises are beginning to set up such departments as information center, which help to make the internal information service more professional and scientific, in order to manage the information resource synthetically. At the present, most enterprises have had LAN(Local Area Net), and many of them are connected to internet.

### 3.2 The exploitation of external resources remains a low level

Although the integration of internal resource has improved a lot gradually, the integration of external resource remains a low level. The external informationalization construction of most enterprises stays as an internet platform which issues news or an E-business platform, and most enterprises lack the information source of themselves.

In order to overcome the fixed shortcomings of multiple production, it is necessary for enterprises to find a breakthrough of right decision-making, and only on the basis of complete information can they make wise decision. No matter whether the scale of the enterprise is large or small, the content of management is almost the same. However, different information is needed according to different levels of management. What the senior leaders of an enterprise need is strategy information, the middle-class leaders favor tactics information, and the profession and task information is for the basic managers. The complete degree of information for an enterprise determines the wise degree of decision-making, and as a result determines the operation risk. Therefore, there are three kinds of information that are necessary for an enterprise: macroscopic economy policy of the country, market information, and the information of the enterprise itself and its competitors. The general channel for information is rather simple, such as some publications, technology communication materials, and some materials gained on business. The patent information and some modern means and equipments such as online search are of such small number, and the materials got in these ways are not complete. The contents of some publications which are compiled and issued by the enterprises themselves are picked up from many sources with low quality, lacking the necessary technology analysis. This results in information contamination, and makes the enterprises lack fixed

information source of themselves. And on the other hand, due to the lack of management of information resource among enterprises, there are a great number of overlaps, dispersion, waste and deficiency. So, the exploitation of external resources is an imperative issue.

#### 4. The background of the external resources integration for an enterprise

Since the 1980's, there has been a great trend worthy of being noticed—the integration trend in circulation industry. Resource integration means that in the specified field, space and time, under the direction of market system, optimizing the investment environment, taking good advantage of various resources, and strengthening the relationship between them, making them regulated in the marketing competition, compensate for each other and influence each other, in order to reach the status of optimization.

The information resource of an enterprise not only includes the internal information arisen from the course of production and operation, but also includes the external information, such as macroscopic social information, market information, finance information, production resource distribution information, relevant scientific and technological information and the information of the competitors, and this information has become the basis of operation decision-making and long-term strategy for an enterprise. So, the velocity, quality and ability for an enterprise to handle, integrate and utilize information have become one of the important symbols of enterprise competitive power.

##### 4.1 the favorite condition for external resource integration—the economy globalization

The application of modern telecom technology and network technology, together with the development of E-business, has promoted the procedure of informationalization of an enterprise; the trend of globalization, informationalization, and integration of the world economy have brought the production elements into circulation at an unimaginable speed, so that broaden the visual field of the enterprise, provide new market opportunities, new external information and new partners, and also represent a larger scale competition and challenge. From the information expressway plan and enterprise "Digital Nervous System" of the USA, to the enterprise informationalization strategy of Japan, the European Union, and many developing countries, a global informationalization revolution has taken place on a large scale. All of these have become the favorite condition for external resource integration.

##### 4.2 the internal reason for external resource integration—the competition of circulation industry

The integration of circulation industry has provided the third profits source, a new way to cut cost, improve

efficiency and gain more profits. In our traditional opinion, the first way to cut cost, is to reduce the variable cost of operation, such as reducing the number of staff, cutting down the material and management consumption. The second way is to reduce the fixed cost, such as running a shop in a marginal region of city with convenient transportation. In nowadays, it has turned to cutting down the operation and logistics cost of the whole circulation procedure by integration of the internal and external information resources, and try to improve the service simultaneously.

##### 4.3 The technology support of the external information resource integration—the development of modern information and network technology

The rapid development of information technology has reduced the cost of information research, information storage, information transfer, and information analysis greatly. In the circulation field, the developed technologies are: POS, CAO, EOS, ASN, EFT, GPS, RF, AI, DSS, and EDI, etc. Besides, there are intranet, extranet and internet. As regard to software, there are MRP, MRPII, ERP, and CRM, which are developing with great potential in Europe and America. Modern information and network technology have provided a potent technology support for the external information resource integration.

##### 4.4 the concept basis of external resource integration ---supply chain management

The supply chain management has become a main subject for the enterprise competition. The supply chain is an integral net-chain function pattern which links the supplier, manufacturer, logistics enterprise and the terminal consumer. Focused on the core enterprise, it begins with purchasing materials, manufactures the unfinished and finished products, and delivers them to the consumers through internet, by control of information stream, material stream, and capital stream.

The supply chain is made up of all the member enterprises, among which there's a core enterprise generally. Spurred on by the demanding information and by media of capital stream, material stream and information, the node enterprises realize the incessant incrementing of the whole supply chain through division of labour and cooperation. The supply chain is a net-chain structure, which has the character of complexity, mobility, customer orientation and intersection.

All of the enterprises on the supply chain share the common information, especially the terminal consumption information of the common mobile change. Try to make the information exact, timely, and visible, eliminate the unnecessary commodity transfer, overstock, by promoting the information sufficient circulation among the enterprises. The information management with accuracy and specification, can weaken the uncertainty between the supply and demand, realize the fact of "replacing the

storage with information”,reduce the storage of products, cut down the possession of flowing capital ,and reduce the economic loss caused by the invalidity and damage in the storage, in order to make the material stream on supply chain flow rationally and optimally, and shorten the production cycle and lower the production cost.

### 5. The settlement plan of external resources integration for an enterprise

The external resources represent to be very multiple and unordered, in another word, the demands of every enterprise for the external resources are so different. Meantime, an enterprise should meet different needs of others, too. Therefore, enterprises should build up several supply chains. In this way, a multiple-to-multiple relationship of resource utilization among enterprises is set up. So, how to deal with this kind of relationship? A third party enterprise is required. By disposing and integrating a great amount of external resources, the Third Party Information Resources Integration(3PIRI) enterprises will surely meet the individual demand for external resources, set up a corresponding external resource platform, and help to run a truly global supply chain management.

3PIRI enterprises can provide services as follows:

#### 5.1 Establish an information database through the membership-system

The establishment of 3PIRI enterprises will lead to the formation of a Star Supply Chain Management(SSCM) system( Figure1), of which 3PIRI enterprise will be the core. Resources can be shared among different enterprises who are the members of the alliance. In this way, each enterprise acts as a member of 3PIRI enterprise, so it

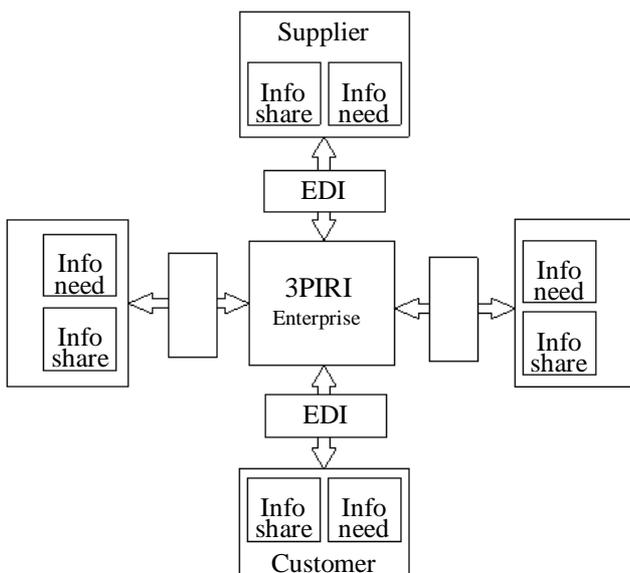


Figure 1: Star Supply Chain Management

should announce its own inner information to 3PIRI enterprise, so as to meet the needs of the other members in it.

#### 5.2 Dispose, integrate and allocate the enterprise’s resources

With their ascendant technology, the third party enterprises can dispose and integrate various information resources collected and fulfill individual needs of the members.

#### 5.3 Provide the enterprises with individual external resources

According to the demands of its members, and with the permission of the resource owner, 3PIRI enterprise can provide useful resources to the demanders with a certain kind of recompense. Thus, an enterprise’s individual need for the external resources is perfectly met, and an external resource platform is precisely built.

#### 5.4 Set up a synthesized electronic commerce platform of enterprise information

On the basis of a great deal of information, 3PIRI can steadily set up a synthesized electronic commerce platform. For one thing ,it can precisely and transparently combine the information of different members through the platform; and for another, this platform can become a synthesized electronic commerce web site, which can proclaim supplying and demanding information to the members.

The establishment of the electronic commerce platform is the foremost mission of 3PIRI enterprise. And This will be a tache which ties the inner and outer information resources of the SSCM system. Consequently, the safety of the platform, the integrality of the data and the management of the interface, will all become vital problems to be solved for 3PIRI enterprise.

### 6. The significance of setting up 3PIRI Enterprise

3PIRI enterprises will become the core of the SSCM system. And it is of great importance to the course of enterprises’ information construction and supply chain management.

#### 6.1 Integrate enterprises’ external resources to make them efficient members of the SSCM system

With 3PIRI enterprise’s entry into the system, a new structure of the supply chain will be created. In this case, there’s no need for a common enterprise to spend so much time, money and energy integrating the external resources. What they do is just to think over “ what do I need and what should I supply?” Therefore, it is much easier for a common enterprise to join in the global system of the supply chain management. Also, it results in realizing the integration of provision, production and marketing, lowering the business cost and decreasing the risk of administration.

#### 6.2 Meet the enterprises’ individual needs for external resources

Different types of enterprises require different kinds of external resources. 3PIRI enterprises can provide transparent interface according to various needs to achieve the goal of realizing individual service. Consequently, only by introducing the third party enterprises can we satisfy the individual needs perfectly.

### 6.3 Establish synthesized electronic commerce platform

Making full use of its information resources, 3PIRI enterprise helps to establish a synthesized electronic commerce platform. In this way, enterprise may operate with E-commerce, and on the other hand, it can be service platform for customers. With this synthesized platform, enterprises can advertise their corporation images and products, and proclaim their demanding information. And customers can enjoy a kind of synthesized service, such as acquiring large amounts of information of different products, services and so on.

### 6.4 The affiliation of 3PIRI enterprises will make the information resources integration more professional

3PIRI enterprises will become the main subject of the information integration. They can make full use of their professional personnel, technology and management so as to professionalize the work of integration. Meanwhile the data redundancy and the incompatibility in data coding can be efficiently reduced or avoided, and the safety of the data can be well ensured. As the information resources are integrated by 3PIRI enterprises, a common enterprise need not reintegrate its own inner resources when several supply chains are set up, and all the external resources it get can be utilized directly as well, which makes the construction of the supply chains much easier than before.

## 7. The Third Party Information Resources Integration enterprises

The business of integrating external resources can be undertaken by the following two types of enterprises.

### 7.1 The Third Party Logistics(3PL) Enterprise

3PL enterprise is a kind of enterprise which can realize the integration of its external logistics. Accordingly, it has a great advantage in the external resources integration management. Moreover, this will grow into a new increasing point of profit in 3PL enterprise.

The membership-system of 3PL provides a prerequisite for the external resources integration. The member corporation is not only the provider of all kinds of information resources, but also the user of the resource. This can make the information supply, demand and acquisition far more simple. At the same time, 3PL enterprise has advanced technology and management, so that it can bring various information resources into the supply chain management.

There are various members in the 3PL enterprises, such as material-supply enterprises, manufacturers, distributors, customers and other benefit interrelated entities. They are all nodes in the supply chain, which makes the Star Supply Chain set up more easily.

### 7.2 Application Service Provider(ASP) enterprises

For a small-scaled enterprise, obviously, it can not afford to take part in the SSCM system with its own limited resources. When ASP first appeared in the USA, it inaugurated a vast space in traditional enterprises using the internet and realizing information construction. Also, ASP has the ability to integrate the external resources in moderate enterprises.

An ASP enterprise owns all or most of the information resources of its member enterprises, which is a most important factor for an ASP enterprise's becoming the core of the external resource integration. ASP sets up supply chains for various enterprises of small scale and medium scale, and helps them realize SSCM with few human resources and little money.

An ASP enterprise has a great advantage in resources and meanwhile in technology. An ASP enterprise holds a set of advanced hardware and software, which will be the technical condition in the resources integration. Accordingly, an ASP enterprise will build up an integration system to deal with all kinds of information more operationally.

## 8. Conclusion

The affiliation of 3PIRI enterprises and the establishment of the SSCM will inevitably result in a new revolution in the enterprise's supply chain management. In this new revolution, external resource integration is an imperative request in a enterprise's management of its information construction. To gain the advantage in competition, a modern enterprise must combine its core ability and technology with other useful resources appropriately, for there comes a new era of cooperative competition, where benefit can be shared in a certain scope.

## References

- [1] A. Deutsch, M.F. Fernandez, and D. Suci, "Storing Semi-structured Data with STORED," Proc. ACM SIGMOD Int'l Conf. Management of Data, ACM Press, New York, 1999, Los Angeles.
- [2] A. Fellows and G. Gow, Wind Resource Estimation in South Africa, Proc. 31 st Meeting of Experts, State of the Art on Wind Resource Estimation, Publication IEA Annex XI, 1999.
- [3] A.H.F. Laender, B. Ribeiro-Neto, and A.S. da Silva, "DEByE— Data Extraction by Example," Data and Knowledge Eng., vol. 40, no. 2, 2002.
- [4] CHEN Li-bo, "Informatization of Enterprise to Cope With the Challenge of E-Commerce", Modern Chemical Industry, April, 2001.

- [5] I.M.R. Evangelista-Filha, A.H.F. Laender, and A.S. Silva, "Querying Semistructured Data by Example: The QSBYE Interface," Proc. Int'l Workshop Information Integration on the Web, UNIRIO, Rio de Janeiro, 2001.
- [6] Jian Wei and Qian Ji-xing, "Research on the Plan of Enterprise Information Based on Supply Chain", Journal of Hubei Automative Industries Institute, Mar. 2001
- [7] K.V. Magalhães, A.H.F. Laender, and A.S. da Silva, "Storing Semistructured Data in Relational Databases," Proc. 8th Symp. String Processing and Information Retrieval, IEEE CS Press, Los Alamitos, Calif., 2001.
- [8] P.B. Golgher et al., "Bootstrapping for Example-Based Data Extraction," Proc. Int'l Conf. Information and Knowledge Management, ACM Press, New York, 2001.
- [9] Wen De-cheng, "Third-Party Logistics Service Provider(3PLs)—The Driver of Supply Chain Innovation", Industry Engineering and Management, No. 2, 2001.
- [10] Zhou Rong-hui, "The Data Resource Organization in Enterprise Information Construction", Journal of Southwest Pretroleum Institute, Vol.23, No.1, 2001.

# Modeling Decision Systems via Uncertain Programming

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*Abstract*—By uncertain programming we mean the optimization theory in generally uncertain (random, fuzzy, rough, fuzzy random, etc.) environments. The main purpose of this paper is to present a brief review on uncertain programming models, and classify them into three broad classes: expected value model, chance-constrained programming and dependent-chance programming. This presentation is based on the book: B. Liu, *Theory and Practice of Uncertain Programming*, Phisica-Verlag, Heidelberg, 2002.

*Keywords*—stochastic programming, fuzzy programming, uncertain programming, hybrid intelligent algorithm

## I. INTRODUCTION

Real-life decisions are usually made in the state of uncertainty. How do we model optimization problems in uncertain environments? How do we solve these models? Uncertain programming theory attempts to answer these questions.

By uncertain programming we mean the optimization theory in uncertain environments. The main topics of uncertain programming are stochastic programming, fuzzy programming, rough programming, fuzzy random programming, random fuzzy programming, random rough programming, rough random programming, fuzzy rough programming, rough fuzzy programming, birandom programming, bifuzzy programming, birough programming, and multifold uncertain programming.

With the requirement of considering randomness, appropriate formulations of stochastic programming have been developed to suit the different purposes of management. The first type of stochastic programming is the *expected value model* (EVM), which optimizes the expected objective functions subject to some expected constraints. The second, *chance-constrained programming* (CCP), was pioneered by Charnes and Cooper [8] as a means of handling uncertainty by specifying a confidence level at which it is desired that the stochastic constraint holds. In practice, there usually are multiple events in a complex stochastic decision system. Sometimes the decision-maker wishes to maximize the chance functions of satisfying these events. In order to model this type of problem, Liu [39] provided a theoretical framework of the third type of stochastic programming, called *dependent-chance programming* (DCP).

Fuzzy programming offers a powerful means of handling optimization problems with fuzzy parameters. Fuzzy programming has been used in different ways in the past. Liu and Liu [57] presented a concept of expected value operator of fuzzy variable and provided a spectrum of fuzzy EVM. Following the idea of stochastic CCP, in a fuzzy decision system we assume that the fuzzy constraints will hold with a possibility level. Thus we have a fuzzy CCP theory. Analogously, following the idea of stochastic DCP, Liu [46] provided the fuzzy DCP theory.

Rough set theory, initialized by Pawlak [71], has been proved to be an excellent mathematical tool dealing with vague description of objects. A fundamental assumption in rough set theory is that any object from a universe is perceived through available information, and such information may not be sufficient to characterize the object exactly. Liu [56] presented a concept of rough space, and defined a rough variable as a measurable function from a rough space to the real line. Expected value operator of rough variable and trust measure of rough event are also suggested. Rough programming is thus proposed.

More generally, Liu [48][56] laid a foundation for optimization theory in uncertain environments, and called such a theory *uncertain programming*.

Fuzzy random variable was developed by Kwakernaak [31][32], and defined as a measurable function from a probability space to a collection of fuzzy variables. Fuzzy random programming is the theory dealing with optimization problems in fuzzy random environments, and has been made in several ways. We will introduce the theoretical framework of fuzzy random EVM (Liu and Liu [61]), fuzzy random CCP (Liu [54]), and fuzzy random DCP (Liu [55]).

Random fuzzy variable was initialized by Liu [56], and defined as a function from a possibility space to a collection of random variables. That is, a random fuzzy variable is a fuzzy variable defined on the universal set of random variables. As a tool of handling random fuzzy decision problems, random fuzzy programming includes random fuzzy EVM (Liu and Liu [60]), random fuzzy CCP (Liu [56]), and random fuzzy DCP (Liu [58]).

In addition to fuzzy random variable and random fuzzy variable, we have also other types of multifold uncertain variables: random rough variable, rough random variable, fuzzy rough variable, rough fuzzy variable, birandom variable, bifuzzy variable, and birough variable. Thus we have random rough programming, rough random programming, fuzzy rough programming, rough fuzzy programming, birandom programming, bifuzzy programming, birough programming, and multifold (three-fold, four-fold, etc.) uncertain programming (Liu [56]).

## II. VARIOUS TYPES OF UNCERTAINTY

Fuzzy variable  $\xi$  is defined as a function from a possibility space  $(\Theta, \mathcal{P}(\Theta), \text{Pos})$  to the real line  $\mathfrak{R}$ . Let  $\tilde{a}_1, \tilde{a}_2, \dots, \tilde{a}_n$  be fuzzy variables, and  $f_j : \mathfrak{R}^n \rightarrow \mathfrak{R}$  be continuous functions,  $j = 1, 2, \dots, m$ . Then the *possibility* of the fuzzy event characterized by  $f_j(\tilde{a}_1, \tilde{a}_2, \dots, \tilde{a}_n) \leq 0$ ,  $j = 1, 2, \dots, m$  is defined by

$$\begin{aligned} & \text{Pos} \{f_j(\tilde{a}_1, \tilde{a}_2, \dots, \tilde{a}_n) \leq 0, j = 1, 2, \dots, m\} \\ &= \sup_{x_1, x_2, \dots, x_n \in \mathfrak{R}} \left\{ \min_{1 \leq i \leq n} \mu_{\tilde{a}_i}(x_i) \mid \begin{array}{l} f_j(x_1, x_2, \dots, x_n) \leq 0 \\ j = 1, 2, \dots, m \end{array} \right\}. \end{aligned}$$

The *necessity* of a fuzzy event is defined as the impossibility of the opposite event. Thus a necessity measure is the dual of possibility measure. The *credibility* of a fuzzy event is defined as the average of its possibility and necessity, i.e.,  $\text{Cr}\{\cdot\} = \frac{1}{2}(\text{Pos}\{\cdot\} + \text{Nec}\{\cdot\})$ .

Liu and Liu [57] presented an *expected value operator* of fuzzy variable. The expected value of  $\xi$  is defined by

$$E[\xi] = \int_0^{+\infty} \text{Cr}\{\xi \geq r\} dr - \int_{-\infty}^0 \text{Cr}\{\xi \leq r\} dr. \quad (1)$$

Fuzzy random variables are mathematical descriptions for fuzzy stochastic phenomena, and are defined in several ways. Kwakernaak [31][32] first introduced the notion of fuzzy random variable. This concept was then developed by Puri and Ralescu [75], Kruse and Meyer [30], and Liu and Liu [59]. Liu and Liu [59] presented a definition of scalar expected value operator and several types of law of large numbers for fuzzy random variables. Liu [54][55] provided a concept of primitive chance measure of fuzzy random event.

Liu [56] initialized the concept of random fuzzy variable which is a function from a possibility space to a collection of random variables. The primitive chance measure of random fuzzy event was defined by Liu [56] as a function from  $[0,1]$  to  $[0,1]$ . The expected value operator of random fuzzy variable was given by Liu and Liu [60].

Let  $\Lambda$  be a nonempty set,  $\mathcal{A}$  be a  $\sigma$ -algebra of subsets of  $\Lambda$ ,  $\Delta$  be an element in  $\mathcal{A}$ , and  $\pi$  be a nonnegative, real-valued, additive set function. Then  $(\Lambda, \Delta, \mathcal{A}, \pi)$  is called a rough space. A rough variable  $\xi$  is defined by Liu [56] as a measurable function from the rough space  $(\Lambda, \Delta, \mathcal{A}, \pi)$  to the real line  $\mathfrak{R}$ . The lower and the upper approximations of the rough variable  $\xi$  are then defined as follows,

$$\underline{\xi} = \{\xi(\lambda) \mid \lambda \in \Delta\}, \quad \bar{\xi} = \{\xi(\lambda) \mid \lambda \in \Lambda\}. \quad (2)$$

Let  $\xi$  be a rough vector on the rough space  $(\Lambda, \Delta, \mathcal{A}, \pi)$ , and  $f_j : \mathfrak{R}^n \rightarrow \mathfrak{R}$  be continuous functions,  $j = 1, 2, \dots, m$ . Then the upper trust of the rough event characterized by  $f_j(\xi) \leq 0, j = 1, 2, \dots, m$  is defined by

$$\text{Tr} \left\{ \left. \begin{matrix} f_j(\xi) \leq 0 \\ j = 1, 2, \dots, m \end{matrix} \right\} = \frac{\pi \{\lambda \in \Lambda \mid f_j(\xi(\lambda)) \leq 0, j = 1, 2, \dots, m\}}{\pi \{\Lambda\}}.$$

Let  $\xi$  be a rough vector on the rough space  $(\Lambda, \Delta, \mathcal{A}, \pi)$ , and  $f_j : \mathfrak{R}^n \rightarrow \mathfrak{R}$  be continuous functions,  $j = 1, 2, \dots, m$ . Then the lower trust of the rough event characterized by  $f_j(\xi) \leq 0, j = 1, 2, \dots, m$  is defined by

$$\text{Tr} \left\{ \left. \begin{matrix} f_j(\xi) \leq 0 \\ j = 1, 2, \dots, m \end{matrix} \right\} = \frac{\pi \{\lambda \in \Delta \mid f_j(\xi(\lambda)) \leq 0, j = 1, 2, \dots, m\}}{\pi \{\Delta\}}.$$

If  $\pi\{\Delta\} = 0$ , then we define

$$\text{Tr} \{f_j(\xi) \leq 0, j = 1, 2, \dots, m\} \equiv \text{Tr} \{f_j(\xi) \leq 0, j = 1, 2, \dots, m\}.$$

Let  $\xi$  be a rough vector on the rough space  $(\Lambda, \Delta, \mathcal{A}, \pi)$ , and  $f_j : \mathfrak{R}^n \rightarrow \mathfrak{R}$  be continuous functions,  $j = 1, 2, \dots, m$ . Then the trust of the rough event is defined as the average value of the lower and upper trusts.

Let  $\xi$  be a rough variable on the rough space  $(\Lambda, \Delta, \mathcal{A}, \pi)$ . The expected value of  $\xi$  is defined by

$$E[\xi] = \int_0^{+\infty} \text{Tr}\{\xi \geq r\} dr - \int_{-\infty}^0 \text{Tr}\{\xi \leq r\} dr. \quad (3)$$

A random rough variable is defined by Liu [56] as a function  $\xi$  from a rough space  $(\Lambda, \Delta, \mathcal{A}, \pi)$  to a collection of random variables such that for any Borel set  $B$  of  $\mathfrak{R}$ ,

$$\xi^*(B)(\lambda) = \text{Pr}\{\xi(\lambda) \in B\} \quad (4)$$

is a measurable function of  $\lambda$ . Let  $\xi$  be a random rough variable defined on the rough space  $(\Lambda, \Delta, \mathcal{A}, \pi)$ . Then its expected value  $E[\xi]$  is defined by

$$\int_0^{+\infty} \text{Tr}\{\lambda \in \Lambda \mid E[\xi(\lambda)] \geq r\} dr - \int_{-\infty}^0 \text{Pr}\{\lambda \in \Lambda \mid E[\xi(\lambda)] \leq r\} dr.$$

Let  $\xi = (\xi_1, \xi_2, \dots, \xi_n)$  be a random rough vector on the rough space  $(\Lambda, \Delta, \mathcal{A}, \pi)$ , and  $f_j : \mathfrak{R}^n \rightarrow \mathfrak{R}$  be continuous functions,  $j = 1, 2, \dots, m$ . Then the primitive chance of random rough event characterized by  $f_j(\xi) \leq 0, j = 1, 2, \dots, m$  is a function from  $[0, 1]$  to  $[0, 1]$ , defined as

$$\begin{aligned} \text{Ch} \{f_j(\xi) \leq 0, j = 1, 2, \dots, m\}(\alpha) \\ = \sup \left\{ \beta \mid \text{Tr} \left\{ \lambda \in \Lambda \mid \text{Pr} \left\{ \left. \begin{matrix} f_j(\xi(\lambda)) \leq 0 \\ j = 1, 2, \dots, m \end{matrix} \right\} \geq \beta \right\} \geq \alpha \right\}. \end{aligned} \quad (5)$$

A rough random variable is defined by Liu [56] as a function  $\xi$  from a probability space  $(\Omega, \mathcal{A}, \text{Pr})$  to a collection of rough variables such that for any Borel set  $B$  of  $\mathfrak{R}$ ,

$$\xi^*(B)(\omega) = \text{Tr}\{\xi(\omega) \in B\} \quad (6)$$

is a measurable function of  $\omega$ . Let  $\xi$  be a rough random variable defined on the probability space  $(\Omega, \mathcal{A}, \text{Pr})$ . Then its expected value  $E[\xi]$  is defined by

$$\int_0^{+\infty} \text{Pr}\{\omega \in \Omega \mid E[\xi(\omega)] \geq r\} dr - \int_{-\infty}^0 \text{Pr}\{\omega \in \Omega \mid E[\xi(\omega)] \leq r\} dr.$$

Let  $\xi = (\xi_1, \xi_2, \dots, \xi_n)$  be a rough random vector on the probability space  $(\Omega, \mathcal{A}, \text{Pr})$ , and  $f_j : \mathfrak{R}^n \rightarrow \mathfrak{R}$  be continuous functions,  $j = 1, 2, \dots, m$ . Then the primitive chance of rough random event characterized by  $f_j(\xi) \leq 0, j = 1, 2, \dots, m$  is a function from  $[0, 1]$  to  $[0, 1]$ , defined as

$$\begin{aligned} \text{Ch} \{f_j(\xi) \leq 0, j = 1, 2, \dots, m\}(\alpha) \\ = \sup \left\{ \beta \mid \text{Pr} \left\{ \omega \in \Omega \mid \text{Tr} \left\{ \left. \begin{matrix} f_j(\xi(\omega)) \leq 0 \\ j = 1, 2, \dots, m \end{matrix} \right\} \geq \beta \right\} \geq \alpha \right\}. \end{aligned}$$

A fuzzy rough variable is defined by Liu [56] as a function  $\xi$  from a rough space  $(\Lambda, \Delta, \mathcal{A}, \pi)$  to a collection of fuzzy variables such that for any Borel set  $B$  of  $\mathfrak{R}$ ,

$$\xi^*(B)(\lambda) = \text{Pos}\{\xi(\lambda) \in B\} \quad (7)$$

is a measurable function of  $\lambda$ . Let  $\xi$  be a fuzzy rough variable defined on the rough space  $(\Lambda, \Delta, \mathcal{A}, \pi)$ . Then its expected value  $E[\xi]$  is defined by

$$\int_0^{+\infty} \text{Tr}\{\lambda \in \Lambda \mid E[\xi(\lambda)] \geq r\} dr - \int_{-\infty}^0 \text{Tr}\{\lambda \in \Lambda \mid E[\xi(\lambda)] \leq r\} dr.$$

Let  $\xi = (\xi_1, \xi_2, \dots, \xi_n)$  be a fuzzy rough vector on the rough space  $(\Lambda, \Delta, \mathcal{A}, \pi)$ , and  $f_j : \mathfrak{R}^n \rightarrow \mathfrak{R}$  be continuous functions,  $j = 1, 2, \dots, m$ . Then the primitive chance of fuzzy rough event characterized by  $f_j(\xi) \leq 0, j = 1, 2, \dots, m$  is a function from  $[0, 1]$  to  $[0, 1]$ , defined as

$$\begin{aligned} \text{Ch} \{f_j(\xi) \leq 0, j = 1, 2, \dots, m\}(\alpha) \\ = \sup \left\{ \beta \mid \text{Tr} \left\{ \lambda \in \Lambda \mid \text{Pos} \left\{ \left. \begin{matrix} f_j(\xi(\lambda)) \leq 0 \\ j = 1, 2, \dots, m \end{matrix} \right\} \geq \beta \right\} \geq \alpha \right\}. \end{aligned}$$

A rough fuzzy variable is defined by Liu [56] as a function from a possibility space  $(\Theta, \mathcal{P}(\Theta), \text{Pos})$  to a collection of rough variables. Let  $\xi$  be a rough fuzzy variable defined on the possibility space  $(\Theta, \mathcal{P}(\Theta), \text{Pos})$ . The expected value  $E[\xi]$  is defined by

$$\int_0^\infty \text{Cr}\{\theta \in \Theta | E[\xi(\theta)] \geq r\} dr - \int_{-\infty}^0 \text{Cr}\{\theta \in \Theta | E[\xi(\theta)] \leq r\} dr.$$

Let  $\xi = (\xi_1, \xi_2, \dots, \xi_n)$  be a rough fuzzy vector on the possibility space  $(\Theta, \mathcal{P}(\Theta), \text{Pos})$ , and  $f_j : \mathbb{R}^n \rightarrow \mathbb{R}$  be continuous functions,  $j = 1, 2, \dots, m$ . Then the primitive chance of rough fuzzy event characterized by  $f_j(\xi) \leq 0, j = 1, 2, \dots, m$  is a function from  $[0, 1]$  to  $[0, 1]$ , defined as

$$\begin{aligned} & \text{Ch}\{f_j(\xi) \leq 0, j = 1, 2, \dots, m\}(\alpha) \\ &= \sup \left\{ \beta \mid \text{Pos} \left\{ \theta \in \Theta \mid \text{Tr} \left\{ \begin{array}{l} f_j(\xi(\theta)) \leq 0 \\ j = 1, 2, \dots, m \end{array} \right\} \geq \beta \right\} \geq \alpha \right\}. \end{aligned}$$

A birandom variable is a function  $\xi$  from a probability space  $(\Omega, \mathcal{A}, \text{Pr})$  to a collection of random variables such that for any Borel set  $B$  of  $\mathbb{R}$ ,

$$\xi^*(B)(\omega) = \text{Pr}\{\xi(\omega) \in B\} \quad (8)$$

is a measurable function of  $\omega$ . Let  $\xi$  be a birandom variable defined on the probability space  $(\Omega, \mathcal{A}, \text{Pr})$ . Then its expected value  $E[\xi]$  is defined by

$$\int_0^\infty \text{Pr}\{\omega \in \Omega | E[\xi(\omega)] \geq r\} dr - \int_{-\infty}^0 \text{Pr}\{\omega \in \Omega | E[\xi(\omega)] \leq r\} dr.$$

Let  $\xi = (\xi_1, \xi_2, \dots, \xi_n)$  be a birandom vector on the probability space  $(\Omega, \mathcal{A}, \text{Pr})$ , and  $f_j : \mathbb{R}^n \rightarrow \mathbb{R}$  be continuous functions,  $j = 1, 2, \dots, m$ . Then the primitive chance of birandom event characterized by  $f_j(\xi) \leq 0, j = 1, 2, \dots, m$  is a function from  $[0, 1]$  to  $[0, 1]$ , defined as

$$\begin{aligned} & \text{Ch}\{f_j(\xi) \leq 0, j = 1, 2, \dots, m\}(\alpha) \\ &= \sup \left\{ \beta \mid \text{Pr} \left\{ \omega \in \Omega \mid \text{Pr} \left\{ \begin{array}{l} f_j(\xi(\omega)) \leq 0 \\ j = 1, 2, \dots, m \end{array} \right\} \geq \beta \right\} \geq \alpha \right\}. \end{aligned}$$

A bifuzzy variable is defined by Liu [53] as a function from a possibility space to a collection of fuzzy variables. Let  $\xi$  be a bifuzzy variable defined on the possibility space  $(\Theta, \mathcal{P}(\Theta), \text{Pos})$ . The expected value  $E[\xi]$  is defined by Liu [53] as

$$\int_0^\infty \text{Cr}\{\theta \in \Theta | E[\xi(\theta)] \geq r\} dr - \int_{-\infty}^0 \text{Cr}\{\theta \in \Theta | E[\xi(\theta)] \leq r\} dr.$$

Let  $\xi = (\xi_1, \xi_2, \dots, \xi_n)$  be a bifuzzy vector on the possibility space  $(\Theta, \mathcal{P}(\Theta), \text{Pos})$ , and  $f_j : \mathbb{R}^n \rightarrow \mathbb{R}$  be continuous functions,  $j = 1, 2, \dots, m$ . Then the primitive chance of bifuzzy event characterized by  $f_j(\xi) \leq 0, j = 1, 2, \dots, m$  is a function from  $[0, 1]$  to  $[0, 1]$ , defined by Liu [53] as

$$\begin{aligned} & \text{Ch}\{f_j(\xi) \leq 0, j = 1, 2, \dots, m\}(\alpha) \\ &= \sup \left\{ \beta \mid \text{Pos} \left\{ \theta \in \Theta \mid \text{Pos} \left\{ \begin{array}{l} f_j(\xi(\theta)) \leq 0 \\ j = 1, 2, \dots, m \end{array} \right\} \geq \beta \right\} \geq \alpha \right\}. \end{aligned}$$

A birough variable is defined by Liu [56] as a function  $\xi$  from a rough space  $(\Lambda, \Delta, \mathcal{A}, \pi)$  to a collection of rough variables such that for any Borel set  $B$  of  $\mathbb{R}$ ,

$$\xi^*(B)(\lambda) = \text{Tr}\{\xi(\lambda) \in B\} \quad (9)$$

is a measurable function of  $\lambda$ . Let  $\xi$  be a birough variable on the rough space  $(\Lambda, \Delta, \mathcal{A}, \pi)$ . Then its expected value  $E[\xi]$  is defined by

$$\int_0^\infty \text{Tr}\{\lambda \in \Lambda | E[\xi(\lambda)] \geq r\} dr - \int_{-\infty}^0 \text{Tr}\{\lambda \in \Lambda | E[\xi(\lambda)] \leq r\} dr.$$

Let  $\xi = (\xi_1, \xi_2, \dots, \xi_n)$  be a birough vector on the rough space  $(\Lambda, \Delta, \mathcal{A}, \pi)$ , and  $f_j : \mathbb{R}^n \rightarrow \mathbb{R}$  be continuous functions,  $j = 1, 2, \dots, m$ . Then the primitive chance of birough event characterized by  $f_j(\xi) \leq 0, j = 1, 2, \dots, m$  is a function from  $[0, 1]$  to  $[0, 1]$ , defined as

$$\begin{aligned} & \text{Ch}\{f_j(\xi) \leq 0, j = 1, 2, \dots, m\}(\alpha) \\ &= \sup \left\{ \beta \mid \text{Tr} \left\{ \lambda \in \Lambda \mid \text{Tr} \left\{ \begin{array}{l} f_j(\xi(\lambda)) \leq 0 \\ j = 1, 2, \dots, m \end{array} \right\} \geq \beta \right\} \geq \alpha \right\}. \end{aligned}$$

A trirandom variable is a function  $\xi$  from a probability space  $(\Omega, \mathcal{A}, \text{Pr})$  to a collection of birandom variables such that for any Borel set  $B$  of  $\mathbb{R}$ ,

$$\xi^*(B)(\omega) = \text{Ch}\{\xi(\omega) \in B\} \quad (10)$$

is a measurable function of  $\omega$ .

A trifuzzy variable is a function from a possibility space to a collection of bifuzzy variables.

A ttrough variable is a function  $\xi$  from a rough space  $(\Lambda, \Delta, \mathcal{A}, \pi)$  to a collection of birough variables such that for any Borel set  $B$  of  $\mathbb{R}$ ,

$$\xi^*(B)(\lambda) = \text{Ch}\{\xi(\lambda) \in B\} \quad (11)$$

is a measurable function of  $\lambda$ .

We may also define other three-fold uncertainty. For example, a fuzzy random rough variable is a function from a rough space to a collection of fuzzy random variables such that for any Borel set  $B$  of  $\mathbb{R}$ ,  $\xi^*(B)(\lambda) = \text{Ch}\{\xi(\lambda) \in B\}$  is a measurable function of  $\lambda$ .

### III. RANKING UNCERTAIN VARIABLES

Let  $\xi$  and  $\eta$  be two uncertain variables. Different from the situation of real numbers, there does not exist a natural ordership in an uncertain world. Thus an important problem appearing in uncertain systems is how to rank uncertain variables. The following ranking methods are suggested.

(i) We say  $\xi > \eta$  if and only if  $E[\xi] > E[\eta]$ , where  $E$  is the expected value operator of uncertain variables. This criterion leads to expected value models.

(ii) We say  $\xi > \eta$  if and only if, for some predetermined confidence level  $\alpha \in (0, 1]$ , we have  $\xi_{\text{sup}}(\alpha) > \eta_{\text{sup}}(\alpha)$ , where  $\xi_{\text{sup}}(\alpha)$  and  $\eta_{\text{sup}}(\alpha)$  are the  $\alpha$ -optimistic values of  $\xi$  and  $\eta$ , respectively. This criterion leads to maximax chance-constrained programming.

(iii) We say  $\xi > \eta$  if and only if, for some predetermined confidence level  $\alpha \in (0, 1]$ , we have  $\xi_{\text{inf}}(\alpha) > \eta_{\text{inf}}(\alpha)$ , where  $\xi_{\text{inf}}(\alpha)$  and  $\eta_{\text{inf}}(\alpha)$  are the  $\alpha$ -pessimistic values of  $\xi$  and  $\eta$ , respectively. This criterion leads to minimax chance-constrained programming.

(iv) We say  $\xi > \eta$  if and only if  $\text{Ch}\{\xi \geq \bar{\tau}\} > \text{Ch}\{\eta \geq \bar{\tau}\}$  for some predetermined level  $\bar{\tau}$ . This criterion leads to dependent-chance programming.

### IV. EXPECTED VALUE MODELS

The first type of uncertain programming is the expected value model (EVM) in which the underlying philosophy is based on selecting the decisions with maximum expected value of return.

We have stochastic, fuzzy, rough, fuzzy random, random fuzzy, fuzzy rough, rough fuzzy, random rough,

rough random, birandom, bifuzzy, and birough EVM. The general form of EVM is formulated as follows,

$$\begin{cases} \max E[f(\mathbf{x}, \boldsymbol{\xi})] \\ \text{subject to:} \\ E[g_j(\mathbf{x}, \boldsymbol{\xi})] \leq 0, \quad j = 1, 2, \dots, p \end{cases} \quad (12)$$

where  $\mathbf{x}$  is a decision vector,  $\boldsymbol{\xi}$  is an uncertain vector,  $f(\mathbf{x}, \boldsymbol{\xi})$  is the return function,  $g_j(\mathbf{x}, \boldsymbol{\xi})$  are uncertain constraint functions for  $j = 1, 2, \dots, p$ , and  $E$  denotes the expected value operator.

The expected value multiobjective programming (EV-MOP) model has the following form,

$$\begin{cases} \max [E[f_1(\mathbf{x}, \boldsymbol{\xi})], E[f_2(\mathbf{x}, \boldsymbol{\xi})], \dots, E[f_m(\mathbf{x}, \boldsymbol{\xi})]] \\ \text{subject to:} \\ E[g_j(\mathbf{x}, \boldsymbol{\xi})] \leq 0, \quad j = 1, 2, \dots, p \end{cases} \quad (13)$$

where  $f_i(\mathbf{x}, \boldsymbol{\xi})$  are return functions for  $i = 1, 2, \dots, m$ .

We can also formulate an uncertain decision system as an expected value goal programming (EVGP) model according to the priority structure and target levels set by the decision-maker,

$$\begin{cases} \min \sum_{j=1}^l P_j \sum_{i=1}^m (u_{ij}d_i^+ + v_{ij}d_i^-) \\ \text{subject to:} \\ E[f_i(\mathbf{x}, \boldsymbol{\xi})] + d_i^- - d_i^+ = b_i, \quad i = 1, 2, \dots, m \\ E[g_j(\mathbf{x}, \boldsymbol{\xi})] \leq 0, \quad j = 1, 2, \dots, p \\ d_i^+, d_i^- \geq 0, \quad i = 1, 2, \dots, m \end{cases} \quad (14)$$

where  $P_j$  is the preemptive priority factor which expresses the relative importance of various goals,  $P_j \gg P_{j+1}$ , for all  $j$ ,  $u_{ij}$  is the weighting factor corresponding to positive deviation for goal  $i$  with priority  $j$  assigned,  $v_{ij}$  is the weighting factor corresponding to negative deviation for goal  $i$  with priority  $j$  assigned,  $d_i^+$  is the positive deviation from the target of goal  $i$ ,  $d_i^-$  is the negative deviation from the target of goal  $i$ ,  $f_i$  is a function in goal constraints,  $b_i$  is the target value according to goal  $i$ ,  $l$  is the number of priorities,  $m$  is the number of goal constraints, and  $p$  is the number of real constraints.

#### V. MAXIMAX CHANCE-CONSTRAINED PROGRAMMING

In this section, we provide a spectrum of maximax chance-constrained programming (CCP) models in which the underlying philosophy is based on selecting the alternative that provides the best optimistic return with a given confidence level. In order to do so, we may measure the uncertain return by its optimistic value.

We have stochastic, fuzzy, rough, fuzzy random, random fuzzy, fuzzy rough, rough fuzzy, random rough, rough random, birandom, bifuzzy, and birough CCP. A single-objective maximax CCP model may be written as follows,

$$\begin{cases} \max \bar{f} \\ \text{subject to:} \\ \text{Ch} \{f(\mathbf{x}, \boldsymbol{\xi}) \geq \bar{f}\} \geq \beta \\ \text{Ch} \{g_j(\mathbf{x}, \boldsymbol{\xi}) \leq 0, j = 1, 2, \dots, p\} \geq \alpha \end{cases} \quad (15)$$

where  $\alpha$  and  $\beta$  are predetermined confidence levels, and  $\max \bar{f}$  will be the  $\beta$ -optimistic return.

Maximax chance-constrained multiobjective programming (CCMOP) may be written as follows,

$$\begin{cases} \max [\bar{f}_1, \bar{f}_2, \dots, \bar{f}_m] \\ \text{subject to:} \\ \text{Ch} \{f_i(\mathbf{x}, \boldsymbol{\xi}) \geq \bar{f}_i\} \geq \beta_i, \quad i = 1, 2, \dots, m \\ \text{Ch} \{g_j(\mathbf{x}, \boldsymbol{\xi}) \leq 0\} \geq \alpha_j, \quad j = 1, 2, \dots, p \end{cases} \quad (16)$$

We can also formulate an uncertain decision system as a minimin chance-constrained goal programming (CCGP) according to the priority structure and target levels set by the decision-maker:

$$\begin{cases} \min \sum_{j=1}^l P_j \sum_{i=1}^m (u_{ij}d_i^+ + v_{ij}d_i^-) \\ \text{subject to:} \\ \text{Ch} \{f_i(\mathbf{x}, \boldsymbol{\xi}) - b_i \leq d_i^+\} \geq \beta_i^+, \quad i = 1, 2, \dots, m \\ \text{Ch} \{b_i - f_i(\mathbf{x}, \boldsymbol{\xi}) \leq d_i^-\} \geq \beta_i^-, \quad i = 1, 2, \dots, m \\ \text{Ch} \{g_j(\mathbf{x}, \boldsymbol{\xi}) \leq 0\} \geq \alpha_j, \quad j = 1, 2, \dots, p \\ d_i^+, d_i^- \geq 0, \quad i = 1, 2, \dots, m \end{cases} \quad (17)$$

where  $P_j$  is the preemptive priority factor which expresses the relative importance of various goals,  $P_j \gg P_{j+1}$ , for all  $j$ ,  $u_{ij}$  is the weighting factor corresponding to positive deviation for goal  $i$  with priority  $j$  assigned,  $v_{ij}$  is the weighting factor corresponding to negative deviation for goal  $i$  with priority  $j$  assigned,  $d_i^+$  is the  $\beta_i^+$ -optimistic positive deviation from the target of goal  $i$ ,  $d_i^-$  is the  $\beta_i^-$ -optimistic negative deviation from the target of goal  $i$ ,  $f_i$  is a function in goal constraints,  $g_j$  is a function in real constraints,  $b_i$  is the target value according to goal  $i$ ,  $l$  is the number of priorities,  $m$  is the number of goal constraints, and  $p$  is the number of real constraints.

#### VI. MINIMAX CHANCE-CONSTRAINED PROGRAMMING

Murphy's law states that "if anything can go wrong, it will". If you believe it, you may select the decision with the best of these worst returns. In order to do so, we may measure the uncertain return by its pessimistic value.

As opposed to optimistic models, we have a spectrum of minimax CCP models in which the underlying philosophy is based on selecting the alternative with the best pessimistic return with a given confidence level. A single-objective minimax CCP model may be written as follows,

$$\begin{cases} \max \min_{\boldsymbol{\xi}} \bar{f} \\ \text{subject to:} \\ \text{Ch} \{f(\mathbf{x}, \boldsymbol{\xi}) \leq \bar{f}\} \geq \beta \\ \text{Ch} \{g_j(\mathbf{x}, \boldsymbol{\xi}) \leq 0, j = 1, 2, \dots, p\} \geq \alpha \end{cases} \quad (18)$$

where  $\min_{\boldsymbol{\xi}} \bar{f}$  is the  $\beta$ -pessimistic return.

When there are multiple objectives, we may employ the minimax CCMOP model,

$$\begin{cases} \max_{\boldsymbol{x}} \left[ \min_{\bar{f}_1} \bar{f}_1, \min_{\bar{f}_2} \bar{f}_2, \dots, \min_{\bar{f}_m} \bar{f}_m \right] \\ \text{subject to:} \\ \text{Ch} \{f_i(\mathbf{x}, \boldsymbol{\xi}) \leq \bar{f}_i\} \geq \beta_i, \quad i = 1, 2, \dots, m \\ \text{Ch} \{g_j(\mathbf{x}, \boldsymbol{\xi}) \leq 0\} \geq \alpha_j, \quad j = 1, 2, \dots, p \end{cases} \quad (19)$$

According to the priority structure and target levels, the minimax CCGP model is written as follows,

$$\begin{cases} \min_{\boldsymbol{x}} \sum_{j=1}^l P_j \sum_{i=1}^m \left[ u_{ij} \left( \max_{d_i^+} d_i^+ \vee 0 \right) + v_{ij} \left( \max_{d_i^-} d_i^- \vee 0 \right) \right] \\ \text{subject to:} \\ \text{Ch} \{f_i(\mathbf{x}, \boldsymbol{\xi}) - b_i \geq d_i^+\} \geq \beta_i^+, \quad i = 1, 2, \dots, m \\ \text{Ch} \{b_i - f_i(\mathbf{x}, \boldsymbol{\xi}) \geq d_i^-\} \geq \beta_i^-, \quad i = 1, 2, \dots, m \\ \text{Ch} \{g_j(\mathbf{x}, \boldsymbol{\xi}) \leq 0\} \geq \alpha_j, \quad j = 1, 2, \dots, p \end{cases}$$

where  $d_i^+ \vee 0$  is the  $\beta_i^+$ -pessimistic positive deviation from the target of goal  $i$ , and  $d_i^- \vee 0$  is the  $\beta_i^-$ -pessimistic negative deviation from the target of goal  $i$ .

## VII. DEPENDENT-CHANCE PROGRAMMING

In order to model uncertain decision problems, we may employ dependent-chance programming (DCP) in which the underlying philosophy is based on selecting the decisions with maximum chance to meet the events. We thus have stochastic, fuzzy, rough, fuzzy random, random fuzzy, fuzzy rough, rough fuzzy, random rough, rough random, birandom, bifuzzy, and birough DCP.

A typical DCP in an uncertain environment is given as follows:

$$\begin{cases} \max \text{Ch}\{h_k(\mathbf{x}, \boldsymbol{\xi}) \leq 0, k = 1, 2, \dots, q\} \\ \text{subject to:} \\ g_j(\mathbf{x}, \boldsymbol{\xi}) \leq 0, \quad j = 1, 2, \dots, p \end{cases} \quad (20)$$

where  $\mathbf{x}$  is a decision vector,  $\boldsymbol{\xi}$  is an uncertain vector, then event is characterized by  $h_k(\mathbf{x}, \boldsymbol{\xi}) \leq 0, k = 1, 2, \dots, q$ , and the uncertain environment is constrained as  $g_j(\mathbf{x}, \boldsymbol{\xi}) \leq 0, j = 1, 2, \dots, p$ .

Since a complex decision system usually undertakes multiple tasks, there undoubtedly exist multiple potential objectives in the decision process. A dependent-chance multiobjective programming (DCMOP) in an uncertain environment has the following form,

$$\begin{cases} \max \begin{bmatrix} \text{Ch}\{h_{1k}(\mathbf{x}, \boldsymbol{\xi}) \leq 0, k = 1, 2, \dots, q_1\} \\ \text{Ch}\{h_{2k}(\mathbf{x}, \boldsymbol{\xi}) \leq 0, k = 1, 2, \dots, q_2\} \\ \dots \\ \text{Ch}\{h_{mk}(\mathbf{x}, \boldsymbol{\xi}) \leq 0, k = 1, 2, \dots, q_m\} \end{bmatrix} \\ \text{subject to:} \\ g_j(\mathbf{x}, \boldsymbol{\xi}) \leq 0, \quad j = 1, 2, \dots, p. \end{cases} \quad (21)$$

We can also formulate an uncertain decision system as a dependent-chance goal programming (DCGP) according to the priority structure and target levels,

$$\begin{cases} \min \sum_{j=1}^l P_j \sum_{i=1}^m (u_{ij} d_i^+ + v_{ij} d_i^-) \\ \text{subject to:} \\ \text{Ch}\left\{ \begin{matrix} h_{ik}(\mathbf{x}, \boldsymbol{\xi}) \leq 0 \\ k = 1, 2, \dots, q_i \end{matrix} \right\} + d_i^- - d_i^+ = b_i, \quad i = 1, 2, \dots, m \\ g_j(\mathbf{x}, \boldsymbol{\xi}) \leq 0, \quad j = 1, 2, \dots, p \\ d_i^+, d_i^- \geq 0, \quad i = 1, 2, \dots, m \end{cases}$$

where  $P_j$  is the preemptive priority factor which expresses the relative importance of various goals,  $P_j \gg P_{j+1}$ , for all  $j$ ,  $u_{ij}$  is the weighting factor corresponding to positive deviation for goal  $i$  with priority  $j$  assigned,  $v_{ij}$  is the weighting factor corresponding to negative deviation for goal  $i$  with priority  $j$  assigned,  $d_i^+$  is the positive deviation from the target of goal  $i$ ,  $d_i^-$  is the negative deviation from the target of goal  $i$ ,  $b_i$  is the target value according to goal  $i$ ,  $l$  is the number of priorities, and  $m$  is the number of goal constraints.

## VIII. UNCERTAIN DYNAMIC PROGRAMMING

Let us consider an  $N$ -stage decision system in which  $\hat{\mathbf{a}} = (a_1, a_2, \dots, a_N)$  represents the state vector,  $\hat{\mathbf{x}} = (x_1, x_2, \dots, x_N)$  the decision vector,  $(\boldsymbol{\xi}_1, \boldsymbol{\xi}_2, \dots, \boldsymbol{\xi}_N)$  the uncertain vector. We also assume that the state transition function is

$$\mathbf{a}_{i+1} = T(\mathbf{a}_i, \mathbf{x}_i, \boldsymbol{\xi}_i), \quad i = 1, 2, \dots, N-1. \quad (22)$$

## Expected Value Dynamic Programming

In order to maximize the discount expected return over the horizon, we may use the following expected value dynamic programming,

$$\begin{cases} f_N(\mathbf{a}) = \max_{E[g(\mathbf{a}, \mathbf{x}, \boldsymbol{\xi}_N)] \leq 0} E[r_N(\mathbf{a}, \mathbf{x}, \boldsymbol{\xi}_N)] \\ f_n(\mathbf{a}) = \max_{E[g(\mathbf{a}, \mathbf{x}, \boldsymbol{\xi}_n)] \leq 0} E[r_n(\mathbf{a}, \mathbf{x}, \boldsymbol{\xi}_n) + \theta f_{n+1}(T(\mathbf{a}, \mathbf{x}, \boldsymbol{\xi}_n))] \\ n \leq N-1 \end{cases}$$

where  $r_i$  are the return functions at the  $i$ th stages,  $i = 1, 2, \dots, N$ , respectively,  $\theta$  is a discount rate,  $0 \leq \theta \leq 1$ , and  $E$  denotes the expected value operator. This type of uncertain (especially stochastic) dynamic programming has been applied to a wide variety of problems, for example, inventory systems.

## Chance-Constrained Dynamic Programming

In order to maximize the discount optimistic return over the horizon, we may use the following chance-constrained dynamic programming,

$$\begin{cases} f_N(\mathbf{a}) = \max_{\text{Ch}\{g(\mathbf{a}, \mathbf{x}, \boldsymbol{\xi}_N) \leq 0\} \geq \alpha} \bar{r}_N(\mathbf{a}, \mathbf{x}, \boldsymbol{\xi}_N) \\ f_n(\mathbf{a}) = \max_{\text{Ch}\{g(\mathbf{a}, \mathbf{x}, \boldsymbol{\xi}_n) \leq 0\} \geq \alpha} \{\bar{r}_n(\mathbf{a}, \mathbf{x}, \boldsymbol{\xi}_n) + \theta f_{n+1}(T(\mathbf{a}, \mathbf{x}, \boldsymbol{\xi}_n))\} \\ n \leq N-1 \end{cases}$$

where the functions  $\bar{r}_i$  are defined by

$$\bar{r}_i(\mathbf{a}, \mathbf{x}, \boldsymbol{\xi}_i) = \sup_{\bar{r}} \{ \bar{r} \mid \text{Ch}\{r_i(\mathbf{a}, \mathbf{x}, \boldsymbol{\xi}_i) \geq \bar{r}\} \geq \beta \} \quad (23)$$

for  $i = 1, 2, \dots, N$ . If we want to maximize the discount pessimistic return over the horizon, then we must define the functions  $\bar{r}_i$  as

$$\bar{r}_i(\mathbf{a}, \mathbf{x}, \boldsymbol{\xi}_i) = \inf_{\bar{r}} \{ \bar{r} \mid \text{Ch}\{r_i(\mathbf{a}, \mathbf{x}, \boldsymbol{\xi}_i) \leq \bar{r}\} \geq \beta \} \quad (24)$$

for  $i = 1, 2, \dots, N$ .

## Dependent-Chance Dynamic Programming

In order to maximize the discount chance over the horizon, we may employ the following dependent-chance dynamic programming,

$$\begin{cases} f_N(\mathbf{a}) = \max_{g(\mathbf{a}, \mathbf{x}, \boldsymbol{\xi}_N) \leq 0} \text{Ch}\{h_N(\mathbf{a}, \mathbf{x}, \boldsymbol{\xi}_N) \leq 0\} \\ f_n(\mathbf{a}) = \max_{g(\mathbf{a}, \mathbf{x}, \boldsymbol{\xi}_n) \leq 0} \{ \text{Ch}\{h_n(\mathbf{a}, \mathbf{x}, \boldsymbol{\xi}_n) \leq 0\} + \theta f_{n+1}(T(\mathbf{a}, \mathbf{x}, \boldsymbol{\xi}_n)) \} \\ n \leq N-1 \end{cases}$$

where  $h_i(\mathbf{a}, \mathbf{x}, \boldsymbol{\xi}_i) \leq 0$  are the events, and  $g(\mathbf{a}, \mathbf{x}, \boldsymbol{\xi}_i) \leq 0$  are the uncertain environments at the  $i$ th stages,  $i = 1, 2, \dots, N$ , respectively.

## IX. UNCERTAIN MULTILEVEL PROGRAMMING

Assume that in a decentralized two-level decision system there is one leader and  $m$  followers. Let  $\mathbf{x}$  and  $\mathbf{y}_i$  be the control vectors of the leader and the  $i$ th followers,  $i = 1, 2, \dots, m$ , respectively. We also assume that the objective functions of the leader and  $i$ th followers are  $F(\mathbf{x}, \mathbf{y}_1, \dots, \mathbf{y}_m, \boldsymbol{\xi})$  and  $f_i(\mathbf{x}, \mathbf{y}_1, \dots, \mathbf{y}_m, \boldsymbol{\xi})$ ,  $i = 1, 2, \dots, m$ , respectively, where  $\boldsymbol{\xi}$  is an uncertain vector.

## Expected Value Multilevel Programming

Let the feasible set of control vector  $\mathbf{x}$  of the leader be defined by the expected constraint

$$E[G(\mathbf{x}, \boldsymbol{\xi})] \leq 0 \quad (25)$$

where  $G$  is a vector-valued function and  $0$  is a vector with zero components. Then for each decision  $\mathbf{x}$  chosen by the leader, the feasibility of control array  $(\mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_m)$  of followers should be dependent on  $\mathbf{x}$ , and generally represented by the expected constraint,

$$E[g(\mathbf{x}, \mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_m, \boldsymbol{\xi})] \leq 0 \quad (26)$$

where  $g$  is a vector-valued function.

Assume that the leader first chooses his control vector  $\mathbf{x}$ , and the followers determine their control array  $(\mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_m)$  after that. In order to maximize the expected return of the leader, we have the following expected value bilevel programming,

$$\left\{ \begin{array}{l} \max_{\mathbf{x}} E[F(\mathbf{x}, \mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_m, \boldsymbol{\xi})] \\ \text{subject to:} \\ E[G(\mathbf{x}, \boldsymbol{\xi})] \leq 0 \\ \text{where each } \mathbf{y}_i (i = 1, 2, \dots, m) \text{ solves} \\ \left\{ \begin{array}{l} \max_{\mathbf{y}_i} E[f_i(\mathbf{x}, \mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_m, \boldsymbol{\xi})] \\ \text{subject to:} \\ E[g(\mathbf{x}, \mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_m, \boldsymbol{\xi})] \leq 0. \end{array} \right. \end{array} \right. \quad (27)$$

A Nash equilibrium of followers is the feasible array  $(\mathbf{y}_1^*, \mathbf{y}_2^*, \dots, \mathbf{y}_m^*)$  with respect to  $\mathbf{x}$  if

$$\begin{aligned} E[f_i(\mathbf{x}, \mathbf{y}_1^*, \dots, \mathbf{y}_{i-1}^*, \mathbf{y}_i, \mathbf{y}_{i+1}^*, \dots, \mathbf{y}_m^*, \boldsymbol{\xi})] \\ \leq E[f_i(\mathbf{x}, \mathbf{y}_1^*, \dots, \mathbf{y}_{i-1}^*, \mathbf{y}_i^*, \mathbf{y}_{i+1}^*, \dots, \mathbf{y}_m^*, \boldsymbol{\xi})] \end{aligned} \quad (28)$$

for any feasible  $(\mathbf{y}_1^*, \dots, \mathbf{y}_{i-1}^*, \mathbf{y}_i, \mathbf{y}_{i+1}^*, \dots, \mathbf{y}_m^*)$  and  $i = 1, 2, \dots, m$ . Let  $\mathbf{x}^*$  be a feasible control vector of the leader and  $(\mathbf{y}_1^*, \mathbf{y}_2^*, \dots, \mathbf{y}_m^*)$  be a Nash equilibrium of followers with respect to  $\mathbf{x}^*$ . We call the array  $(\mathbf{x}^*, \mathbf{y}_1^*, \mathbf{y}_2^*, \dots, \mathbf{y}_m^*)$  a Stackelberg-Nash equilibrium to the expected value bilevel programming (27) if and only if,

$$E[F(\bar{\mathbf{x}}, \bar{\mathbf{y}}_1, \bar{\mathbf{y}}_2, \dots, \bar{\mathbf{y}}_m, \boldsymbol{\xi})] \leq E[F(\mathbf{x}^*, \mathbf{y}_1^*, \mathbf{y}_2^*, \dots, \mathbf{y}_m^*, \boldsymbol{\xi})] \quad (29)$$

for any feasible  $\bar{\mathbf{x}}$  and the Nash equilibrium  $(\bar{\mathbf{y}}_1, \bar{\mathbf{y}}_2, \dots, \bar{\mathbf{y}}_m)$  with respect to  $\bar{\mathbf{x}}$ .

#### Chance-Constrained Multilevel Programming

In order to maximize the optimistic return subject to the chance constraint, we may use the following chance-constrained bilevel programming,

$$\left\{ \begin{array}{l} \max_{\mathbf{x}} \bar{F} \\ \text{subject to:} \\ \text{Ch}\{F(\mathbf{x}, \mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_m, \boldsymbol{\xi}) \geq \bar{F}\} \geq \beta \\ \text{Ch}\{G(\mathbf{x}, \boldsymbol{\xi}) \leq 0\} \geq \alpha \\ \text{where each } \mathbf{y}_i (i = 1, 2, \dots, m) \text{ solves} \\ \left\{ \begin{array}{l} \max_{\mathbf{y}_i} \bar{f}_i \\ \text{subject to:} \\ \text{Ch}\{f_i(\mathbf{x}, \mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_m, \boldsymbol{\xi}) \geq \bar{f}_i\} \geq \beta_i \\ \text{Ch}\{g(\mathbf{x}, \mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_m, \boldsymbol{\xi}) \leq 0\} \geq \alpha_i \end{array} \right. \end{array} \right. \quad (30)$$

where  $\alpha, \beta, \alpha_i, \beta_i, i = 1, 2, \dots, m$  are predetermined confidence levels.

A Nash equilibrium of followers is the feasible array  $(\mathbf{y}_1^*, \mathbf{y}_2^*, \dots, \mathbf{y}_m^*)$  with respect to  $\mathbf{x}$  if

$$\begin{aligned} \bar{f}_i(\mathbf{x}, \mathbf{y}_1^*, \dots, \mathbf{y}_{i-1}^*, \mathbf{y}_i, \mathbf{y}_{i+1}^*, \dots, \mathbf{y}_m^*) \\ \leq \bar{f}_i(\mathbf{x}, \mathbf{y}_1^*, \dots, \mathbf{y}_{i-1}^*, \mathbf{y}_i^*, \mathbf{y}_{i+1}^*, \dots, \mathbf{y}_m^*) \end{aligned} \quad (31)$$

for any feasible array  $(\mathbf{y}_1^*, \dots, \mathbf{y}_{i-1}^*, \mathbf{y}_i, \mathbf{y}_{i+1}^*, \dots, \mathbf{y}_m^*)$  and  $i = 1, 2, \dots, m$ . Let  $\mathbf{x}^*$  be a feasible control vector of the

leader and  $(\mathbf{y}_1^*, \mathbf{y}_2^*, \dots, \mathbf{y}_m^*)$  be a Nash equilibrium of followers with respect to  $\mathbf{x}^*$ . The array  $(\mathbf{x}^*, \mathbf{y}_1^*, \mathbf{y}_2^*, \dots, \mathbf{y}_m^*)$  is called a Stackelberg-Nash equilibrium to the chance-constrained bilevel programming (30) if and only if,

$$\bar{F}(\bar{\mathbf{x}}, \bar{\mathbf{y}}_1, \bar{\mathbf{y}}_2, \dots, \bar{\mathbf{y}}_m) \leq \bar{F}(\mathbf{x}^*, \mathbf{y}_1^*, \mathbf{y}_2^*, \dots, \mathbf{y}_m^*) \quad (32)$$

for any feasible control vector  $\bar{\mathbf{x}}$  and the Nash equilibrium  $(\bar{\mathbf{y}}_1, \bar{\mathbf{y}}_2, \dots, \bar{\mathbf{y}}_m)$  with respect to  $\bar{\mathbf{x}}$ .

In order to maximize the pessimistic return, we have the following minimax chance-constrained bilevel programming,

$$\left\{ \begin{array}{l} \max_{\mathbf{x}} \min_{\bar{F}} \bar{F} \\ \text{subject to:} \\ \text{Ch}\{F(\mathbf{x}, \mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_m, \boldsymbol{\xi}) \leq \bar{F}\} \geq \beta \\ \text{Ch}\{G(\mathbf{x}, \boldsymbol{\xi}) \leq 0\} \geq \alpha \\ \text{where each } \mathbf{y}_i (i = 1, 2, \dots, m) \text{ solves} \\ \left\{ \begin{array}{l} \max_{\mathbf{y}_i} \min_{\bar{f}_i} \bar{f}_i \\ \text{subject to:} \\ \text{Ch}\{f_i(\mathbf{x}, \mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_m, \boldsymbol{\xi}) \leq \bar{f}_i\} \geq \beta_i \\ \text{Ch}\{g(\mathbf{x}, \mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_m, \boldsymbol{\xi}) \leq 0\} \geq \alpha_i. \end{array} \right. \end{array} \right. \quad (33)$$

#### Dependent-Chance Multilevel Programming

Let  $H(\mathbf{x}, \mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_m, \boldsymbol{\xi}) \leq 0$  and  $h_i(\mathbf{x}, \mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_m, \boldsymbol{\xi}) \leq 0$  be the events of the leader and  $i$ th followers,  $i = 1, 2, \dots, m$ , respectively. In order to maximize the chance function of the leader, we have the following dependent-chance bilevel programming,

$$\left\{ \begin{array}{l} \max_{\mathbf{x}} \text{Ch}\{H(\mathbf{x}, \mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_m, \boldsymbol{\xi}) \leq 0\} \\ \text{subject to:} \\ G(\mathbf{x}, \boldsymbol{\xi}) \leq 0 \\ \text{where each } \mathbf{y}_i (i = 1, 2, \dots, m) \text{ solves} \\ \left\{ \begin{array}{l} \max_{\mathbf{y}_i} \text{Ch}\{h_i(\mathbf{x}, \mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_m, \boldsymbol{\xi}) \leq 0\} \\ \text{subject to:} \\ g(\mathbf{x}, \mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_m, \boldsymbol{\xi}) \leq 0. \end{array} \right. \end{array} \right. \quad (34)$$

The feasible array  $(\mathbf{y}_1^*, \mathbf{y}_2^*, \dots, \mathbf{y}_m^*)$  is called a Nash equilibrium of followers with respect to  $\mathbf{x}$  if

$$\begin{aligned} \text{Ch}\{h_i(\mathbf{x}, \mathbf{y}_1^*, \dots, \mathbf{y}_{i-1}^*, \mathbf{y}_i, \mathbf{y}_{i+1}^*, \dots, \mathbf{y}_m^*, \boldsymbol{\xi}) \leq 0\} \\ \leq \text{Ch}\{h_i(\mathbf{x}, \mathbf{y}_1^*, \dots, \mathbf{y}_{i-1}^*, \mathbf{y}_i^*, \mathbf{y}_{i+1}^*, \dots, \mathbf{y}_m^*, \boldsymbol{\xi}) \leq 0\} \end{aligned} \quad (35)$$

for any feasible array  $(\mathbf{y}_1^*, \dots, \mathbf{y}_{i-1}^*, \mathbf{y}_i, \mathbf{y}_{i+1}^*, \dots, \mathbf{y}_m^*)$  and  $i = 1, 2, \dots, m$ . Let  $\mathbf{x}^*$  be a feasible control vector of the leader and  $(\mathbf{y}_1^*, \mathbf{y}_2^*, \dots, \mathbf{y}_m^*)$  be a Nash equilibrium of followers with respect to  $\mathbf{x}^*$ . We call the array  $(\mathbf{x}^*, \mathbf{y}_1^*, \mathbf{y}_2^*, \dots, \mathbf{y}_m^*)$  a Stackelberg-Nash equilibrium to the dependent-chance bilevel programming (34) if and only if,

$$\begin{aligned} \text{Ch}\{H(\bar{\mathbf{x}}, \bar{\mathbf{y}}_1, \bar{\mathbf{y}}_2, \dots, \bar{\mathbf{y}}_m, \boldsymbol{\xi}) \leq 0\} \\ \leq \text{Ch}\{H(\mathbf{x}^*, \mathbf{y}_1^*, \mathbf{y}_2^*, \dots, \mathbf{y}_m^*, \boldsymbol{\xi}) \leq 0\} \end{aligned}$$

for any feasible control vector  $\bar{\mathbf{x}}$  and the Nash equilibrium  $(\bar{\mathbf{y}}_1, \bar{\mathbf{y}}_2, \dots, \bar{\mathbf{y}}_m)$  with respect to  $\bar{\mathbf{x}}$ .

#### X. HYBRID INTELLIGENT ALGORITHMS

This section will introduce the general principle of designing hybrid intelligent algorithms. Essentially, there are three types of uncertain function arising in the area of fuzzy programming:

$$\begin{aligned} U_1 : \mathbf{x} &\rightarrow E[f(\mathbf{x}, \boldsymbol{\xi})], \\ U_2 : \mathbf{x} &\rightarrow \text{Pos/Cr/Nec}\{f_j(\mathbf{x}, \boldsymbol{\xi}) \leq 0, j = 1, 2, \dots, p\}, \\ U_3 : \mathbf{x} &\rightarrow \max\{\bar{f} \mid \text{Pos/Cr/Nec}\{f(\mathbf{x}, \boldsymbol{\xi}) \geq \bar{f}\} \geq \alpha\}. \end{aligned}$$

We may compute the uncertain functions by simulations. However, fuzzy simulation is obviously a time-consuming process. In order to speed up the process, we may generate input-output data for each type of uncertain function. Then we train a feedforward NN to approximate the uncertain function using the generated training data. For solving general fuzzy programming models, we may embed the trained NN into GA, thus producing a hybrid intelligent algorithm. The general procedure of hybrid intelligent algorithm is listed as follows,

*Step 1: Generate training input-output data for uncertain functions by fuzzy simulations.*

*Step 2: Train a neural network to approximate the uncertain functions according to the generated training data.*

*Step 3: Initialize pop\_size chromosomes whose feasibility may be checked by the trained neural network.*

*Step 4: Update the chromosomes by crossover and mutation operations in which the feasibility of offspring may be checked by the trained neural networks.*

*Step 5: Calculate the objective values for all chromosomes by the trained neural networks.*

*Step 6: Compute the fitness of each chromosome according to the objective values.*

*Step 7: Select the chromosomes by spinning the roulette wheel.*

*Step 8: Repeat the fourth to seventh steps for a given number of cycles.*

*Step 9: Report the best chromosome as the optimal solution.*

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#### REFERENCES

- [1] Bellman, R.E., and Zadeh, L.A., Decision making in a fuzzy environment, *Management Science*, Vol. 17, 141–164, 1970.
- [2] Bouchon-Meunier, B., Kreinovich, V., Lokshin, A., and Nguyen, H.T., On the formulation of optimization under elastic constraints (with control in mind), *Fuzzy Sets and Systems*, Vol. 81, 5–29, 1996.
- [3] Buckley, J.J., Possibility and necessity in optimization, *Fuzzy Sets and Systems*, Vol. 25, 1–13, 1988.
- [4] Buckley, J.J., Stochastic versus possibilistic programming, *Fuzzy Sets and Systems*, Vol. 34, 173–177, 1990.
- [5] Buckley, J.J., Multiobjective possibilistic linear programming, *Fuzzy Sets and Systems*, Vol. 35, 23–28, 1990.
- [6] Buckley, J.J., and Hayashi, Y., Fuzzy genetic algorithm and applications, *Fuzzy Sets and Systems*, Vol. 61, 129–136, 1994.
- [7] Buckley, J.J., and Feuring, T., Evolutionary algorithm solution to fuzzy problems: Fuzzy linear programming, *Fuzzy Sets and Systems*, Vol. 109, No. 1, 35–53, 2000.
- [8] Charnes, A. and Cooper, W.W., Chance-constrained programming, *Management Science*, Vol. 6, No. 1, 73–79, 1959.
- [9] Charnes, A. and Cooper, W.W., *Management Models and Industrial Applications of Linear Programming*, Wiley, New York, 1961.
- [10] Dubois, D., and Prade, H., *Fuzzy Sets and Systems, Theory and Applications*, Academic Press, New York, 1980.
- [11] Dubois, D., and Prade, H., Fuzzy cardinality and the modeling of imprecise quantification, *Fuzzy Sets and Systems*, Vol. 16, 199–230, 1985.
- [12] Dubois, D., and Prade, H., *Possibility Theory*, Plenum, New York, 1988.
- [13] Dubois, D., and Prade, H., Rough fuzzy sets and fuzzy rough sets, *International Journal of General Systems*, Vol. 17, 191–200, 1990.
- [14] Gao, J., and Liu, B., New primitive chance measures of fuzzy random event, *International Journal of Fuzzy Systems*, Vol. 3, No. 4, 527–531, 2001.
- [15] Gen, M., Liu, B., and Ida, K., Evolution program for deterministic and stochastic optimizations, *European Journal of Operational Research*, Vol. 94, No. 3, 618–625, 1996.
- [16] Inuiguchi, M., Ichihashi, H., and Kume Y., Relationships between modality constrained programming problems and various fuzzy mathematical programming problems, *Fuzzy Sets and Systems*, Vol. 49, 243–259, 1992.
- [17] Inuiguchi, M., Ichihashi, H., and Kume, Y., Modality constrained programming problems: An unified approach to fuzzy mathematical programming problems in the setting of possibility theory, *Information Sciences*, Vol. 67, 93–126, 1993.
- [18] Inuiguchi, M., and Ramík, J., Possibilistic linear programming: A brief review of fuzzy mathematical programming and a comparison with stochastic programming in portfolio selection problem, *Fuzzy Sets and Systems*, Vol. 111, No. 1, 3–28, 2000.
- [19] Iwamura, K. and Liu, B., A genetic algorithm for chance constrained programming, *Journal of Information & Optimization Sciences*, Vol. 17, No. 2, 40–47, 1996.
- [20] Iwamura, K. and Liu, B., Chance constrained integer programming models for capital budgeting in fuzzy environments, *Journal of the Operational Research Society*, Vol. 49, No. 8, 854–860, 1998.
- [21] Iwamura, K. and Liu, B., Stochastic operation models for open inventory networks, *Journal of Information & Optimization Sciences*, Vol.20, No. 3, 347–363, 1999.
- [22] Iwamura, K. and Liu, B., Dependent-chance integer programming applied to capital budgeting, *Journal of the Operations Research Society of Japan*, Vol. 42, No. 2, 117–127, 1999.
- [23] Kall, P. and Wallace, S.W., *Stochastic Programming*, Wiley, Chichester, 1994.
- [24] Kaufman, A. and Gupta, M.M., *Introduction to Fuzzy Arithmetic: Theory and Applications*, Van Nostrand Reinhold, New York, 1985.
- [25] Kaufman, A. and Gupta, M.M., *Fuzzy Mathematical Models in Engineering and Management Science*, 2nd ed., North-Holland, Amsterdam, 1991.
- [26] Keown, A.J. and Martin, J.D., A chance constrained goal programming model for working capital management, *Engng Econ.*, Vol. 22, 153–174, 1977.
- [27] Keown, A.J., A chance-constrained goal programming model for bank liquidity management, *Decision Sciences*, Vol. 9, 93–106, 1978.
- [28] Keown, A.J. and Taylor, B.W., A chance-constrained integer goal programming model for capital budgeting in the production area, *Journal of the Operational Research Society*, Vol. 31, No. 7, 579–589, 1980.
- [29] Klir, G.J. and Folger, T.A., *Fuzzy Sets, Uncertainty, and Information*, Prentice-Hall, Englewood Cliffs, NJ, 1980.
- [30] Kruse, R., and Meyer, K.D., *Statistics with Vague Data*, D. Reidel Publishing Company, Dordrecht, 1987.
- [31] Kwakernaak, H., Fuzzy random variables I, *Information Sciences*, Vol. 15, 1–29, 1978.
- [32] Kwakernaak H., Fuzzy random variables II, *Information Sciences*, Vol. 17, 153–178, 1979.
- [33] Lai, Y.-J. and Hwang, C.-L., A new approach to some possibilistic linear programming problems, *Fuzzy Sets and Systems*, Vol. 49, 121–133, 1992.
- [34] Lai, Y.-J. and Hwang, C.-L., *Fuzzy Multiple Objective Decision Making: Methods and Applications*, Springer-Verlag, New York, 1994.
- [35] Lee, E.S., and Li, R.J., Fuzzy multiple objective programming and compromise programming with Pareto optimum, *Fuzzy Sets and Systems*, Vol. 53, 275–288, 1993.
- [36] Lee, E.S., Fuzzy multiple level programming, *Applied Mathematics and Computation*, Vol. 120, 79–90, 2001.
- [37] Liu, B. and Ku, C., Dependent-chance goal programming and an application, *Journal of Systems Engineering & Electronics*, Vol. 4, No. 2, 40–47, 1993.
- [38] Liu, B., Dependent-chance goal programming and its genetic algorithm based approach, *Mathematical and Computer Modelling*, Vol. 24, No. 7, 43–52, 1996.
- [39] Liu, B., Dependent-chance programming: A class of stochas-

- tic programming, *Computers & Mathematics with Applications*, Vol. 34, No. 12, 89–104, 1997.
- [40] Liu, B., and Iwamura, K., Modelling stochastic decision systems using dependent-chance programming, *European Journal of Operational Research*, Vol. 101, No. 1, 193–203, 1997.
- [41] Liu, B., and Iwamura, K., Chance constrained programming with fuzzy parameters, *Fuzzy Sets and Systems*, Vol. 94, No. 2, 227–237, 1998.
- [42] Liu, B., and Iwamura, K., A note on chance constrained programming with fuzzy coefficients, *Fuzzy Sets and Systems*, Vol. 100, Nos. 1–3, 229–233, 1998.
- [43] Liu, B., Stackelberg-Nash equilibrium for multilevel programming with multiple followers using genetic algorithms, *Computers & Mathematics with Applications*, Vol. 36, No. 7, 79–89, 1998.
- [44] Liu, B., Minimax chance constrained programming models for fuzzy decision systems, *Information Sciences*, Vol. 112, Nos. 1–4, 25–38, 1998.
- [45] Liu, B., and Zhao, R., *Stochastic Programming and Fuzzy Programming*, Tsinghua University Press, Beijing, 1998.
- [46] Liu, B., Dependent-chance programming with fuzzy decisions, *IEEE Transactions on Fuzzy Systems*, Vol. 7, No. 3, 354–360, 1999.
- [47] Liu, B., and Esogbue, A.O., *Decision Criteria and Optimal Inventory Processes*, Kluwer Academic Publishers, Boston, 1999.
- [48] Liu, B., *Uncertain Programming*, Wiley, New York, 1999.
- [49] Liu, B., Dependent-chance programming in fuzzy environments, *Fuzzy Sets and Systems*, Vol. 109, No. 1, 97–106, 2000.
- [50] Liu, B., and Iwamura, K., Topological optimization models for communication network with multiple reliability goals, *Computers & Mathematics with Applications*, Vol. 39, 59–69, 2000.
- [51] Liu, B., Uncertain programming: A unifying optimization theory in various uncertain environments, *Applied Mathematics and Computation*, Vol. 120, Nos. 1–3, 227–234, 2001.
- [52] Liu, B., and Iwamura, K., Fuzzy programming with fuzzy decisions and fuzzy simulation-based genetic algorithm, *Fuzzy Sets and Systems*, Vol. 122, No. 2, 253–262, 2001.
- [53] Liu, B., Toward fuzzy optimization without mathematical ambiguity, *Fuzzy Optimization and Decision Making*, Vol. 1, No. 1, 43–63, 2002.
- [54] Liu, B., Fuzzy random chance-constrained programming, *IEEE Transactions on Fuzzy Systems*, Vol. 9, No. 5, 713–720, 2001.
- [55] Liu, B., Fuzzy random dependent-chance programming, *IEEE Transactions on Fuzzy Systems*, Vol. 9, No. 5, 721–726, 2001.
- [56] Liu, B., *Theory and Practice of Uncertain Programming*, Physica-Verlag, Heidelberg, 2002.
- [57] Liu, B., and Liu, Y.-K., Expected value of fuzzy variable and fuzzy expected value models, *IEEE Transactions on Fuzzy Systems*, Vol. 10, No. 4, 445–450, 2002.
- [58] Liu, B., Random fuzzy dependent-chance programming and its hybrid intelligent algorithm, *Information Sciences*, Vol. 141, No. 3–4, 259–271, 2002.
- [59] Liu, Y.-K., and Liu, B., Fuzzy random variables: A scalar expected value, *Fuzzy Optimization and Decision Making*, to be published.
- [60] Liu, Y.-K., and Liu, B., Expected value operator of random fuzzy variable and random fuzzy expected value models, *International Journal of Uncertainty, Fuzziness & Knowledge-Based Systems*, to be published.
- [61] Liu, Y.-K., and Liu, B., Expected value models in fuzzy random decision systems with a hybrid intelligent algorithm, Technical Report, 2000.
- [62] Luhandjula, M.K., Linear programming under randomness and fuzziness, *Fuzzy Sets and Systems*, Vol. 10, 45–55, 1983.
- [63] Luhandjula, M.K., On possibilistic linear programming, *Fuzzy Sets and Systems*, Vol. 18, 15–30, 1986.
- [64] Luhandjula, M.K., Fuzzy optimization: An appraisal, *Fuzzy Sets and Systems*, Vol. 30, 257–282, 1989.
- [65] Luhandjula, M.K., Fuzziness and randomness in an optimization framework, *Fuzzy Sets and Systems*, Vol. 77, 291–297, 1996.
- [66] Luhandjula M.K. and M.M. Gupta, On fuzzy stochastic optimization, *Fuzzy Sets and Systems*, Vol. 81, 47–55, 1996.
- [67] Maleki, H.R., Tata, M., and Mashinchi, M., Linear programming with fuzzy variables, *Fuzzy Sets and Systems*, Vol. 109, No. 1, 21–33, 2000.
- [68] Mareschal, B., Stochastic multicriteria decision making and uncertainty, *European Journal of Operational Research*, Vol. 26, No. 1, 58–64, 1986.
- [69] Nahmias, S., Fuzzy variables, *Fuzzy Sets and Systems*, Vol. 1, 97–110, 1978.
- [70] Ostasicwicz, W., A new approach to fuzzy programming, *Fuzzy Sets and Systems*, Vol. 7, 139–152, 1982.
- [71] Pawlak, Z., Rough sets, *International Journal of Information and Computer Sciences*, Vol. 11, No. 5, 341–356, 1982.
- [72] Pawlak, Z., Rough sets and fuzzy sets, *Fuzzy sets and Systems*, Vol. 17, 99–102, 1985.
- [73] Pawlak, Z., *Rough Sets: Theoretical Aspects of Reasoning about Data*, Kluwer Academic Publishers, Dordrecht, 1991.
- [74] Pawlak, Z., and Slowinski, R., Rough set approach to multi-attribute decision analysis, *European Journal of Operational Research*, Vol. 72, 443–459, 1994.
- [75] Puri, M.L. and Ralescu, D., Fuzzy random variables, *Journal of Mathematical Analysis and Applications*, Vol. 114, 409–422, 1986.
- [76] Ramík, J., Extension principle in fuzzy optimization, *Fuzzy Sets and Systems*, Vol. 19, 29–35, 1986.
- [77] Ramík, J., and Rommelfanger H., Fuzzy mathematical programming based on some inequality relations, *Fuzzy Sets and Systems*, Vol. 81, 77–88, 1996.
- [78] Roubens, M., and Teghem Jr. J., Comparison of methodologies for fuzzy and stochastic multi-objective programming, *Fuzzy Sets and Systems*, Vol. 42, 119–132, 1991.
- [79] Saade, J.J., Maximization of a function over a fuzzy domain, *Fuzzy Sets and Systems*, Vol. 62, 55–70, 1994.
- [80] Sakawa, M., and Yano, H., Feasibility and Pareto optimality for multiobjective nonlinear programming problems with fuzzy parameters, *Fuzzy Sets and Systems*, Vol. 43, 1–15, 1991.
- [81] Slowinski, R. and Teghem, Jr. J., Fuzzy versus stochastic approaches to multicriteria linear programming under uncertainty, *Naval Research Logistics*, Vol. 35, 673–695, 1988.
- [82] Slowinski, R., and Vanderpooten, D., A generalized definition of rough approximations based on similarity, *IEEE Transactions on Knowledge and Data Engineering*, Vol. 12, No. 2, 331–336, 2000.
- [83] Tanaka, H., Guo, P., and Zimmermann, H.-J., Possibility distribution of fuzzy decision variables obtained from possibilistic linear programming problems, *Fuzzy Sets and Systems*, Vol. 113, 323–332, 2000.
- [84] Wang G. and Z. Qiao, Linear programming with fuzzy random variable coefficients, *Fuzzy Sets and Systems*, Vol. 57, 295–311, 1993.
- [85] Yager, R.R., Mathematical programming with fuzzy constraints and a preference on the objective, *Kybernetes*, Vol. 9, 285–291, 1979.
- [86] Yager, R.R., Generalized probabilities of fuzzy events from fuzzy belief structures, *Information Sciences*, Vol. 28, 45–62, 1982.
- [87] Yager, R.R., On ordered weighted averaging aggregation operators in multicriteria decision making, *IEEE Transactions on Systems, Man and Cybernetics*, Vol. 18, 183–190, 1988.
- [88] Yager, R.R., On the specificity of a possibility distribution, *Fuzzy Sets and Systems*, Vol. 50, 279–292, 1992.
- [89] Yager, R.R., Decision making with fuzzy probability assessments, *IEEE Transactions on Fuzzy Systems*, Vol. 7, 462–466, 1999.
- [90] Yazenin, A.V., Fuzzy and stochastic programming, *Fuzzy Sets and Systems*, Vol. 22, 171–180, 1987.
- [91] Yazenin, A.V., On the problem of possibilistic optimization, *Fuzzy Sets and Systems*, Vol. 81, 133–140, 1996.
- [92] Zadeh, L.A., Fuzzy sets, *Information and Control*, Vol. 8, 338–353, 1965.
- [93] Zadeh, L.A., Outline of a new approach to the analysis of complex systems and decision processes, *IEEE Transactions on Systems, Man and Cybernetics*, Vol. 3, 28–44, 1973.

- [94] Zadeh, L.A., Fuzzy sets as a basis for a theory of possibility, *Fuzzy Sets and Systems*, Vol. 1, 3–28, 1978.
- [95] Zhao, R., and Liu, B., Stochastic programming models for general redundancy optimization problems, *IEEE Transactions on Reliability*, to be published.
- [96] Zimmermann, H.-J., Fuzzy mathematical programming, *Computers and Operations Research*, Vol. 10, 291–298, 1983.
- [97] Zimmermann, H.-J., Applications of fuzzy set theory to mathematical programming, *Information Sciences*, Vol. 36, 29–58, 1985.
- [98] Zimmermann, H.-J., *Fuzzy Set Theory and its Applications*, Kluwer Academic Publishers, Boston, 1985.

# A Kind of Parallel Evolutionary Algorithms and Its Application in E-Business

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## Abstract

Parallel Genetic Algorithms (PGAs) were used to simultaneously optimize the structure and weights for feedforward neural networks. Aiming at its large-scale application in common distributed network system, a concentrative coarse-grained model for parallel evolutionary neural networks is designed and realized in a laboratorial distributed computation environment, and the initial results of experiments indicate that the parallel model can quicken the searching process and improve the evolutionary efficiency. For the parallel characteristics, this method can analyze massive information during the process of e-business. Several application scopes of this method in e-business are discussed also in this paper .

**Key words** Parallel Evolutionary Neural Networks; Distributed computation; E-business

## 1. Introduction

The application of Artificial Neural Networks (ANNs) has been extended to many areas in recent years. Common practices are usually involved with using back propagation (BP) algorithms on structure-predefined full-connected feed-forward neural networks for connection weights adjustment. Unfortunately such training is often time-consuming, especially for large-scale problem, and user-dependent for ANNs' architecture definition, which is crucial to the training process, while still a difficult decision, without optimum rules to follow.

Evolutionary Neural Networks (ENNs) provide a prominent alternative neural-network training method. They take advantage of evolutionary algorithms' (EAs) global searching ability, not only automatically optimize ANNs' architecture according to particular tasks, but also dynamically improve ANNs' generalization performance. However, when encountered with large-scale problem, ENNs also suffer from considerable computation expense due to complex network architecture.

Parallel Evolutionary Neural Networks (PENNs) have the potential to find fittest ANNs in significantly less time than serial ENNs. Aiming at PENNs' extensive application in common distributed computer network, we have been devoted to the analysis, design and implementation of parallel algorithms in distributed

computation environments, compared to numerous studies in multi-processor workstations.

In this paper, we introduce a kind of parallel model specially designed for PENN in distributed system, on the basis of which a parallel evolutionary algorithm is realized to optimize the architecture and weights of feed-forward neural networks simultaneously.

As we know, the most popular evolutionary algorithm used in ENNs is Genetic Algorithms (GAs). There are generally three kinds of evolution in GA-based ENN, i.e., the evolution of connection weights, of architectures and of learning rules, according to the level to which evolutionary search procedures come into ANNs<sup>[1]</sup>. If the learning rules are pre-defined and fixed, the main procedures of the two kinds of evolution are so similar that we can combine them into one evolutionary algorithm, which will be described later.

A successful design of ENN requires careful consideration about several crucial aspects<sup>[2]</sup>:

### 1) Encoding Scheme

How to map the ENNs' structure (connection weights and architecture) into one-dimension chromosomes? Using binary strings or real numbers to represent the connection weights? How to arrange the sequence of connection weights to reflect the network architecture?

### 2) Fitness Function

How to construct the fitness function? Need additional items besides training error? If necessary, how to decide their weights?

### 3) Genetic Operators

Which types of genetic operators are involved in the ENN? What specific operations do they execute respectively?

All these designing details have great influence on evolutionary process and final result, and need paying enough attention to. When discussing about our PENN later, we will describe these aspects thoroughly.

The parallelization of ENN is based on the parallelism of GA, and has been performed in four following ways:

### 1) The parallelization of single individual fitness evaluation

The work of fitness evaluation is most time-consuming in ENN, which is involved with decoding, training iteration and encoding. Using parallel computation technology on single individual fitness

evaluation will hopefully improve evaluation efficiency.

- 2) The parallelization of individual fitness evaluation in population

In a population, different individual's fitness evaluation is independent and can be performed on different processors simultaneously and independently.

- 3) The parallelization of individual-generating

The genetic operations involved in child-generation, i.e., reproduce, crossover, mutation etc, can be implemented on different individuals simultaneously and independently.

- 4) The parallelization based on population grouping

The evolutionary process of one or a group of individuals in the population is independent of each other, so this provides another way of parallel ENN based on population grouping: divide the population into several groups, assign each group a processor, evolve these population groups simultaneously, and exchange some individual information among groups at proper times to speed up global evolution progress.

The former three parallel methods haven't change ENN's overall frame, while the fourth, by breaking the population into groups and exchanging information periodically, has potential influence on ENN's general behavior and is most popular due to its simple realization in multiple-processor machine and distributed computer network system.

## 2. PENN based on CCG parallel model in distributed environments

### 2.1 CCG parallel model in distributed computation environment

Although distributed computer network is more convenient, abundant and economical parallel environment compared to multiple-processor machine, the much lower coupling degree make it much difficult to coordinate and communicate among different processors, which needs global schedule and control by software programming. Meanwhile, the communication efficiency in distributed environment is subject to many external impacts, such as connecting material, flow rate, flow amount etc., which is much less steady and reliable than multi-processor machine. Designing and realizing parallel models for distributed system must take these differences under careful consideration, and thus more difficult to deal with, which may be the reason why there is so little related work now.

The centralized coarse-grained model we present here is spirited by Cantu-paz E<sup>[3]</sup> about the master-slave parallel algorithm(We still use the master-slave notation in our model)and other previous work on coarse-grained parallel model. Our parallel model takes advantage of both master-slave and coarse-grained parallel model and we consider it fit well for the distributed system. Taking three distributed paralleling processors for example, the CCG model is illustrated in Figure1.

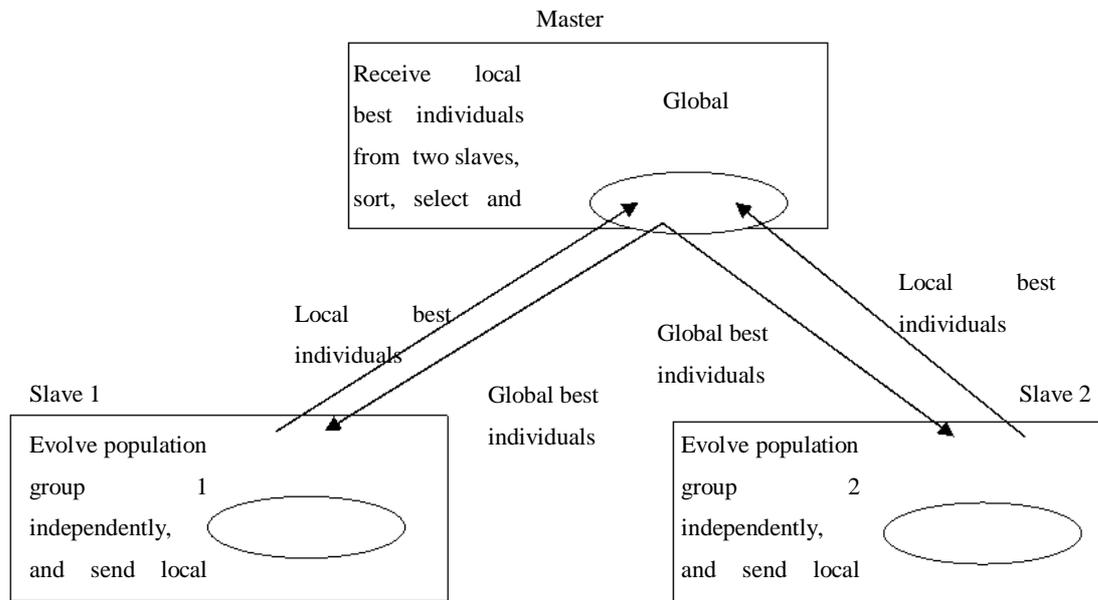


Figure 1 CCG model for three distributed paralleling processors

### 2.1.1 CCG model

According to different functions, divide distributed paralleling processors into one master and several slaves. On the other hand, following the idea of parallelization based on population grouping, divide the evolution population into several groups, one group for one slave. Each slave evolves its population group independently, and sends the master its local best individuals after a pre-specified number of generations. After the master receives all slaves' local best individuals, it incorporate them into one group, which is called global best population group, sorts the group according to individuals' fitness, selects global best individuals and broadcasts them back to slaves. Slaves keep waiting until they receive the feedback from master and continue their evolution process before next transfer.

In the model, the evolution processes on different slaves are paralleling, while the works on master and slaves are actually been carried on sequentially.

#### 1) Function specification

The main responsibility of master is receiving local best individuals from all slaves, sorting them by fitness, selecting the global best ones and broadcasts them back to slaves, also keeping record of the best individual and storing global best population group. In contrast, the slaves are in charge of ENN on its own population group, sending local best, receiving global best, replacing local worst.

#### 2) Communication and information exchange

In CCG model, inter-processor communication only takes place between master and slaves. This reflects the design intention for realization simplicity. When one slave finishes its current evolution period, it sends the master a signal as transfer request, begins data transferring if master isn't busy (if busy, blocks and waits for master's ready message), and then wait until receiving global best individuals from master.

For the master, it keeps sleeping until being woken by a slave's transfer request, and begins the uninterruptible data transferring (if another slave ask for service during this time, send a busy signal and put it to the end of the waiting line). After the transfer is finished, it arouses the first slave in the waiting line by sending a ready message and starts the next data transferring until it gets all slaves' local best.

#### 3) CCG versus traditional parallel models

The CCG model has inherited the population-grouping and information-exchanging ideas from traditional coarse-grained model, while introduces centralizing control to overcome the unstableness in distributed system. On the other hand, CCG is quite similar to traditional centralizing parallel model at the first glimpse, while compared to global evolution and selection in centralizing model, CCG performs local evolution and selection, which is the most distinct advantage of coarse-grained towards centralizing.

### 2.1.2 Key parameters

There are several key paralleling parameters in the design and realization of CCG, whose different values have great influence on CCG model's behavior and characteristics.

#### 2.1.2.1 Transferring Scale

The transferring scale of inter-processor individual exchanging is determined by two parameters: transferring rate and transferring period. Large-scale transferring will make CCG acting like global centralizing model, while small scale will enforce the independence of each ENN.

##### (1) Transferring rate

Transferring rate is the amount of the individuals transferred, which is often defined by absolute number or percent of the population group. A typical transferring rate is ten to twenty percent of the population group.

##### (2) Transferring period

Transferring period determines the time interval between two transfers, which is usually one or several evolutionary generations on slaves. Generally, higher transferring rate is accompanied by longer transferring period.

#### 2.1.2.2 Transferring Strategy

Transferring strategy includes two aspects, transferring selection and transferring replacement. Other than the strategy we mentioned in CCG description, there are still different choices.

##### (1) Transferring selection

Transferring selection is responsible for selecting individuals transferred. Common method is selecting one or several best individuals, while selection based on fitness proportion is also optional.

##### (2) Transferring replacement

In most cases, one or several worst individuals are replaced. While similar with transferring selection, the replacement can also be based on fitness-proportion selection, which can bring some selection pressure on better individuals in the population group.

## 2.2 Parallel Evolutionary Neural Networks

Just as we have mentioned, our PENN aims at evolving neural networks' architecture and connection weights simultaneously. Focusing on the three fundamental problems in ENN designing, below we will present the details for our evolutionary algorithm, which mainly deals with feedforward neural networks with linear threshold unit and sigmoid transfer function.

### 2.2.1 Encoding Scheme

We use a Java class to describe the neural networks, which is the encoding representation of the individual.

In the Java class, the first parameter represents the number of neurons in the hidden layer, and then we use an array to store all the weights and connection

information of the network. The final two parameters denote the individual's fitness and relative fitness.

In order to encode the weights and connections exactly and convenient for genetic operations, we adopt real number representation instead of binary code, which also makes the length of gene flexible and shorter. Using real number representation, we are able to take following additional advantages:

- Crossover can be made only between weights;
- Mutation is just adding a random number to the weight existing, instead of replacing it;
- Smaller population size because of the gene-length flexibility.

### 2.2.2 Fitness Function

Assume that use a training-set on individual  $i$  and get the total network error  $E(net_i)$ , which is the sum of the errors between the object output vectors and the simulative output vectors. Obviously, the higher the total error is, the lower the individual's fitness.

In addition to the error, we expect the structure of the neural network is as simple as possible, given the same network performance. The simpleness means the optimized architecture should have minimum number of neurons and connections. In order to control the complexity of the neural network, one control item is added to the error function: CH. C is a positive control constant, which we call the complexity coefficients of the network; H is the number of neuron of the hidden layer. Certainly, we expect a CH value as low as possible, given a pre-specified C value.

As a conclusion, we define our fitness function as this:

$$pop[i].fitness = f(net_i, t) = \frac{1}{1 + E(net_i) + CH} \quad (1)$$

The value of coefficient C is suggested to be in interval (0,0.5).

### 2.2.3 Genetic Operators

The usual genetic operators include selection, breeding, crossover and mutation, which are separately implemented to a certain individual in pre-determined probabilities.

**Selection strategy:** the evolutionary algorithm adopts standard roulette selection operator. The selection probability of individual  $net_i$ , according to the roulette selection strategy, is:

$$p_i = pop[i].relativefit = \frac{pop[i].fitness}{\sum_{j=1}^N pop[j].fitness} \quad (2)$$

$N$  is the size of the population group.

**Breeding operator:** select parents from the population according to the selection strategy and the individual selection probability (its relative fitness), and then copy these parents to current population without any change.

**Crossover operator:** the same number of weights is selected from the two parents stochastically and independently. Exchange the weights, and thus get two offsprings.

**Mutation operator:** as we are evolving neural network's architecture and connection weights simultaneously, the mutation operators should include architecture mutation and connection-weights mutation correspondingly.

#### 1) Architecture mutation

Four architecture mutation operations are carried out in certain probabilities, that is:

- Delete some neurons in hidden layer and (or) the connections and their weights. When only delete the connections, we set the corresponding weights zero.
- Insert some neurons into each hidden layer and (or) the connections and their weights, and generate the corresponding weights randomly.
- For those deleted connections, repair them with special probability.
- Mutate the connection weights with adaptive mutation rate.

#### 2) Connection-weights mutation

The mutation operation we present here is based on adaptive mutation rate, satisfying the evolutionary requirement that when the individual has lower fitness value, the mutation should be higher. So we introduce the simulated annealing algorithms, in which the mutation temperature can be defined as:

$$T = \frac{1}{f(net_i)} \quad (3)$$

Assuming the weight  $v$  will be mutated, the definition scope is (a,b), then

$$v' = \begin{cases} y + \Delta(T, b - v), & rnd(2) = 0 \\ v - \Delta(T, v - a), & rnd(2) = 1 \end{cases} \quad (4)$$

Here the value field of  $\Delta(T, y)$  is (0,y), and the probability that  $\Delta(T, y)$  gets close to zero increases when T reduces.

$$\Delta(T, y) = y(1 - r^{T^\lambda}) \quad (5)$$

Here  $r$  is a random real number from 0 to 1,  $\lambda$  is a parameter that determine the adaptive degree, the value is from 2 to 5 commonly.

## 3. Results and Discussion

PENN based on CCG is realized in a one-master-two-slave scope. The parallel experimental platform is constructed in a three-PC distributed LAN, using Java programming and data-package transferring

technology, which is convenient to build and easy to expand to larger-scale application.

The values of some key experimental parameters are listed in Table 1.

Table 1 Values of key experimental parameters

Population Size (Slave group)	100
Transferring Rate	5%
Transferring Period	10
EA Mutation Rate	0.001
EA Crossover Rate	0.2
Network complexity coefficient C	0.1
Adaptive Mutation parameter $\lambda$	2
Transferring Selection Strategy	Best
Transferring Replacement Strategy	Worst

### 3.1 Experimental Results

The initial experiment results demonstrate that the paralleling evolutionary algorithm based on CCG has remarkably quickened the search process and improve the solution quality at some extent. A typical experimental result is shown in Table 2, which is the comparison between ENN and PENN on XOR Problem.

Table 2 Comparison results of ENN and PENN

	Number of Generations	Searching Time (ms)	Best Individual Fitness	Population Error
ENN	200	883090	0.707	0.481
PENN	100 for each slave	471480	0.751	0.068

The improvement of solution quality illustrates that the PENN based on CCG model is not the simple sum-up of two independent paralleling processes, but has changed the fundamental behavior of ENN by best individual transferring and exchanging. That is similar to different offspring quality in marriages between close relatives or far relatives, the latter of which is often better because of gene mutation and exchange.

### 3.2 Efficiency Analysis

In order to measure the paralleling efficiency, we also examined the relative loading degree of the three processors and total communication expense. A typical result is shown in Table 3.

Table 3 Run-Time Data of PENN

	Run Time	Block Time	Package Time*	Compu. Time	Com. rate**
Master	341140	267970	15250	37930	88.9%
Slave 1	341140	25609	15630	299901	12.1%
Slave 2	341140	23555	15720	301865	11.5%

\*Including data packing and unpacking time, and time unit is ms

\*\*Communication Expense rate = (Block time + Data package time) / Run time

From the table, we can find that much of master's run time is spent on blocking, that is, waiting for slaves' evolutionary process. It is partly due to CCG's centralizing structure and is a big waste of master processor's resource. A further improvement on this problem is adding an evolutionary process to Master processor, which is to say, having the master assuming the responsibilities of both a master and a slave. It will hopefully reduce the master's idling time and increase global paralleling efficiency.

## 4. PENN in e-business

In the information era, more and more data are stored in enterprise database systems. It is still a big problem for enterprises to utilize these data well, especially for decision. The barriers are not the amount of data, but how to cope with mass data, that is, the efficiency of analyzing data is the bottleneck.

PENN provides an efficiency way for enterprise data analyzing, especially in the distributed environment. It can be used as data mining tools to classify or recognize the special pattern hidden in the data.

As a classifying tool, PENN can process the data in a distributed way, such as the customers' data in a commercial bank; it can be used to find the most promising customers. It also can be used as predicting tool, and time serial analyzing tool.

At present, a new method for portfolio selection based on PENN is studied, and this work will optimize the portfolio in a distributed environment. A lot of this kind of works can be done, if we find a way to process data efficiently and effectively. With the rapid development of e-business, more and more data crowd in Internet. PENN can be used to treat this data traffic problem also, and we will improve PENN methods to fill this demand in the future.

## 5. Conclusion

In this paper, we introduce a kind of paralleling model CCG specially designed for distributed system, which takes the advantage of both classical centralizing and coarse-grained paralleling model and demonstrated to fit for parallel algorithms in distributed computation environments.

On the basis of CCG, a parallel evolutionary algorithm is designed and realized to optimize the architecture and weights of feed-forward neural networks simultaneously. It adopts the idea of simulated annealing and has been demonstrated better performance than sequential algorithms both in searching time and solution quality.

Further work is expected on the convergence and behavior analysis of PENN. For its practical application, the parameters also need further careful analysis and adjustment according to different tasks.

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## Reference

- [1] X. Yao, "A review of Evolutionary Artificial Neural Networks," *International Journal of Intelligent Systems*, Vol.8, No.4, 1993, pp.539-567
- [2] V. Maniezzo, "Genetic Evolution of the Topology and Weight Distribution of Neural Networks," *IEEE Trans. On Neural Networks*, Vol.5, No.1, 1994, pp.39-53
- [3] Cantu-paz E, "Designing efficient master-slave parallel genetic algorithms", ITR 97004. Urbana, IL: University of Illinois Urbana- Champaign, 1997
- [4] Y. Zhu, J. Chen, "Studies on genetic multiplayer feedforward neural networks and the development of GMNN. IEEE International Conference on Systems, Man, and Cybernetics [C]. Tokyo: SMC'99 Publication Committee, 1999
- [5] X,T. Guo, Y. Zhu, "Evolutionary Neural Networks based on Genetic Algorithms", *Tsinghua Science and Technology*, Vol.40, No.10, 2000, pp.116-119

# The Evolution of Internal Representation

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## Abstract

To develop an appropriate internal representation, a deterministic learning algorithm that has an ability to adjust not only weights but also the number of adopted hidden nodes is proposed. The key mechanisms are (1) the recruiting mechanism that recruits proper extra hidden nodes, and (2) the reasoning mechanism that prunes potentially irrelevant hidden nodes. This learning algorithm can make use of external environmental clues to develop an internal representation appropriate for the required mapping. The encoding problem and the parity problem is used to demonstrate the performance of the proposed algorithm. The experimental results are clearly positive.

Keywords: internal representation, Generalized Delta Rule, recruiting mechanism, pruning mechanism.

## 1. Introduction

In modern finance, derivatives such as futures and options play increasingly prominent roles in risk management and price speculative activities. Owing to the high-leverage characteristic involved in derivative trading, investors can gain enormous profits with a small amount of capital if they can accurately predict the market's direction. Financial markets, however, can be influenced by many factors, such as, political events, general economic conditions, and traders' expectations. Predicting the financial market's movements is considered to be rather difficult in general. Movements in market prices are not random. Rather, they behave in a highly nonlinear, dynamic manner. The standard random walk assumption of futures prices may merely be a veil of randomness that shrouds a messy nonlinear process (see, for example, [2][4][7]). To make the forecasting of futures prices more reliable, the application of Artificial Neural Networks (ANN), especially the multi-layered feed-forward network [10], have received extensive attention[7][8][15].

Instead of directly deriving the nonlinear equation, these ANN tries to develop an appropriate internal representation for such forecasting problem. In general, a nonlinear forecasting problem is like a problem of finding a nonlinear equation to capture the general pattern of a relationship between the independent variables  $x_j$ 's and the dependent variables  $y_i$ 's. The form of the equation is  $y_i = F_i(x)$ , where  $x$  is the vector of independent variables  $x_j$  and  $F_i$  is a nonlinear function derived from a given data set of samples  $\{(x_1, t_1), \dots, (x_N, t_N)\}$  with  $t_i$  being the

observed value of  $y_i$  corresponding to  $c_x$ . In the context of multi-layered feed-forward network, as shown in Figure 1, the information  $x$  coming to the input nodes is recoded into an internal representation  $h \equiv (h_1, h_2, \dots, h_p)^t$  and the output  $O_i$ , the estimated value of  $y_i$ , is generated by the internal representation  $h$  rather than by the original pattern  $x$ . "Input patterns can always be encoded, if there are enough hidden units, in a form so that the appropriate output pattern can be generated from any input pattern," as mentioned in [10].

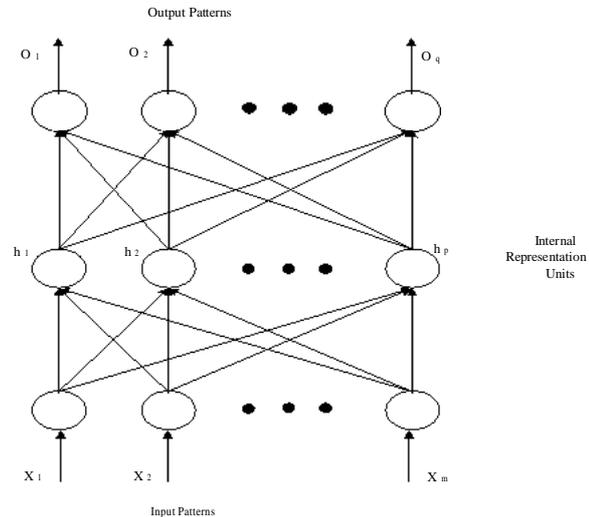


Figure 1. An ANN with a layer of hidden nodes.

Let's take the multi-layered feed-forward network with the hyperbolic tangent ( $\tanh$ ) function [14][10],

where  $\tanh(x) \equiv \frac{e^x - e^{-x}}{e^x + e^{-x}}$ , used in all output and

hidden nodes as the illustration. Given the  $c^{\text{th}}$  stimulus  $c_x$ , the activation value of the  $i^{\text{th}}$  hidden node  $h(c_x, {}_2w_i)$  and the activation values of the  $l^{\text{th}}$  output node  $O(c_x, {}_3w_l, {}_2w)$  are as follows:

$$h(c_x, {}_2w_i) \equiv \tanh({}_2w_{i0} + \sum_{j=1}^m {}_2w_{ij} c_x) \quad (1)$$

$$\begin{aligned} O(c_x, {}_3w_l, {}_2w) &\equiv \tanh({}_3w_{l0} + \sum_{i=1}^p {}_3w_{li} h(c_x, {}_2w_i)) \\ &= \tanh({}_3w_{l0} + \sum_{i=1}^p {}_3w_{li} \tanh({}_2w_{i0} + \sum_{j=1}^m {}_2w_{ij} c_x)) \end{aligned} \quad (2)$$

where  $m, p$  and  $q$  are the numbers of input, hidden and output nodes, respectively;  ${}_2w_{i0}$  is the bias of the  $i^{\text{th}}$  hidden

node,  ${}_2w_{ij}$  is the weight of connection between the  $j^{\text{th}}$  input node and the  $i^{\text{th}}$  hidden node,  ${}_3w_{i0}$  is the bias of the  $i^{\text{th}}$  output node, and  ${}_3w_{li}$  is the weight of the connection between  $i^{\text{th}}$  hidden nodes and the  $l^{\text{th}}$  output node. Denote the bold character a vector and the superscript  $t$  indicates the transposition:  ${}_2w_i^t \equiv ({}_2w_{i0}, {}_2w_{i1}, \dots, {}_2w_{im})$ ,  ${}_2w^t \equiv ({}_2w_1^t, {}_2w_2^t, \dots, {}_2w_p^t)$ ,  ${}_3w_l^t \equiv ({}_3w_{l0}, {}_3w_{l1}, \dots, {}_3w_{lp})$ ,  ${}_3w^t \equiv ({}_3w_1^t, {}_3w_2^t, \dots, {}_3w_q^t)$ , and  $w^t \equiv ({}_2w^t, {}_3w^t)$ .

Given a set of training samples  $\{(x_1, t), \dots, (x_N, t)\}$ , the learning goal is to seek a  $(w, p)$  that renders  $|O(c, x, {}_3w_l, {}_2w) - c_t| < \varepsilon$  for all  $c \in \{1, \dots, N\}$  and all  $l$ , where  $\varepsilon$  is a given acceptable tolerance, says  $10^{-6}$ . In general, the learning can be recognized as a minimization of the sum of residual squares  $E(w, p)$  via setting as

$$\min_{w,p} E(w,p) \equiv \min_{w,p} \sum_{c=1}^N \sum_{l=1}^q (O(c, x, {}_3w_l, {}_2w) - c_t)^2 \quad (3)$$

This is a complicated unconstrained nonlinear programming problem.

The process of an optimization algorithm applied to problem (3) is similar to the process of searching along the surface defined by the sum of residual squares in the  $\{w, p\}$  space composed of all possible  $(w, p)$ . Instead of desperately obtaining the globally optimal solution  $(w^*, p^*)$  in a complicated nonlinear environment, many research are motivated to develop a reasonable algorithm for searching an acceptable learning solution  $(w, p)$  that renders  $|O(c, x, {}_3w_l, {}_2w) - c_t| < \varepsilon$  for all  $c \in \{1, \dots, N\}$  and all  $l$ .

Developing such algorithm is not easy due to managing with the following characteristics: (1) the  $\{w, p\}$  space is unbounded since the number of possible  $(w, p)$  is infinite; (2) the surface defined by values of  $E(w, p)$  over the  $\{w, p\}$  space is non-differentiable since, for example, changes in the value of  $p$  is discrete and can have discontinuous effects on the value of  $E(w, p)$ ; (3) the surface is non-analyzable since the mapping from  $(w, p)$  to the value of  $E(w, p)$  is not yet analyzable; (4) the surface is complex and deceptive since values of  $E(w, p)$  with similar  $(w, p)$  may be dramatically different, and with quite different  $(w, p)$  may be very similar. These characteristics lead to hardly having any solid theoretical support in developing a reasonable learning algorithm.

In the context of internal representation, equations (1) and (2) state that (1) the vector of activation values of all hidden nodes  $h(x, {}_2w) \equiv (h(x, {}_2w_1), \dots, h(x, {}_2w_p))^t$  is the internal representation of the input pattern  $x$ , and (2) the activation values of all output nodes are calculated based on this internal representation, i.e.,  $O(c, x, {}_3w_l, {}_2w) \equiv O(h(c, x, {}_2w), {}_3w_l)$  for all  $l$ . The activation functions adopted on all hidden nodes are predefined and fixed; usually, they are semi-linear [10]. Thus the internal presentation evolves when the values of  $p$  and  ${}_2w$  are altered.

The internal representation is a level-adjacent mapping from the  $\{x\}$  space to the  $\{h\}$  space. Level-adjacent mapping means that level-adjacent points in the previous-layer space are mapped to neighboring points in the latter-layer space [14]. While the nearness of two points in the latter-layer space is measures with their

(direct) distance, the level-adjacency between two points in the previous-layer space is measured with the difference of their associated activation level. Owing to the linear characteristic of computing the net input value and the semi-linear characteristic of the activation function adopted in equations (1) and (2), there are level-adjacent mapping from the input layer  $\{x\}$  space to the hidden layer  $\{h\}$  space, and from the hidden layer  $\{h\}$  space to the output layer  $\{O\}$  space.

In the learning stage, the position of the training stimuli  $\{x_1, \dots, x_N\}$  in the  $\{x\}$  space are given and fixed; however,  $\{h(x_1, {}_2w), \dots, h(x_N, {}_2w)\}$  are determined by  $p$  and  ${}_2w$ , and each  $O(c, x, {}_3w_l, {}_2w)$  is determined with  $h(c, x, {}_2w)$  and  ${}_3w_l$ . As stated in [14], (1) no matter what kind of learning algorithm is used, the resulting mapping between two consecutive layers is always a level-adjacent mapping; (2) the crux of learning is to adjust  $p$  and  ${}_2w$  to render the internal representation appropriate for the learning task. An internal representation is appropriate for the task if there is a  ${}_3w$  such that  $|O(h(c, x, {}_2w), {}_3w_l) - c_t| < \varepsilon$  for all  $c \in \{1, \dots, N\}$  and all  $l$ . Although the learning of ANN should derive appropriate  $p$  and  ${}_2w$  from the training samples to obtain an appropriate internal representation, the development of the internal representation is relevant with the current value of  $p$  and  $w$ , not the current value of  $p$  and  ${}_2w$ .

In literatures, there are two categories of learning algorithms for multi-layered feed-forward network: the evolutionary ANN (EANN) algorithms, which are stochastic, and the weight-and-structure-change learning algorithms, which are deterministic.

Over past years, researchers have applied evolutionary computation to problems whose solution space is so large and highly complex that it is difficult to employ conventional optimization procedures to search for a global optimum. Evolutionary computation refers to a collection of stochastic searching algorithms whose designs are based upon the ideas of genetic inheritance and the Darwinian principle of the survival of the fittest (natural selection). There are several different styles of evolutionary algorithms: evolutionary strategies (ES), evolutionary programming (EP), genetic algorithms (GA), and genetic programming (GP). All of them model the searching process over the solution space by mimicking a biological evolution process. They differ mainly in the evolution operators involved and the representation of the solution space. Most researchers believe that, basically, evolutionary computation should not be considered as a kind of optimization technique to compete with other alternative techniques, but an optimization principle to be incorporated into existing techniques. Thus, they propose to apply EP, GA and GP to the determination of the network structure of an ANN. This gives rise to three classes of ANN, EPNN, GANN, and GPNN. All of these classes are portions of EANN. The most promising EANNs involve a global search algorithm that is stochastic [17].

In contrast, all weight-and-structure-change learning algorithms alter  $w$  and  $p$  in a deterministic way; for example, the tiling algorithm [9], the cascade-correlation

(CC) algorithm [5], the upstart algorithm [6], the W&S algorithm [16], the CTN algorithm [3], and the softening algorithm [12][13][14]. Without following the ideas of genetic inheritance and natural selection, they adjust the network structure in one of the following ways:

(1) Destructively: using excess hidden nodes initially and pruning (removing) least effective hidden nodes during the learning process; e.g., W&S algorithm and CTN algorithm;

(2) Constructively: using less hidden nodes initially and recruiting (adding) more hidden nodes during the learning process; e.g., the tiling algorithm, CC algorithm, and the upstart algorithm;

(3) Aggregately: using only one hidden node initially, and recruiting as well as pruning hidden nodes during the learning process; e.g., the softening algorithm.

These deterministic learning algorithms have an ability to develop an appropriate internal representation via recruiting/pruning hidden nodes and altering the weights during the learning process.

Here we introduce a deterministic learning algorithm that makes use of sequentially presented training samples to adjust the values of  $w$  and  $p$  to develop an internal representation appropriate for the required mapping. More over, this learning algorithm guarantees an acceptable learning result, without the binary output restriction. Recall that a learning result is acceptable if  $|\mathcal{O}(c, x, w) - c| < \varepsilon$  for all  $c \in \{1, \dots, N\}$  and all  $l$ , where  $\varepsilon$  is a given acceptable tolerance.

This paper is organized as follows. The proposed learning algorithm and its theoretical justification are introduced in Section 2. Empirical justification of the proposed algorithm is given in Section 3. The encoding problem and the parity problem [11] will be used to demonstrate the performance of the proposed algorithm. Finally, conclusions and future work are presented in Section 4. For the simplicity of presentation, all theoretical proofs are given in the Appendix.

## 2. The Proposed Learning Algorithm

To simplify the presentation, without lose of the generality, we let  $q = 1$  in the explanation of our design. Table 1 presents the general procedure and Figure 2 displays the flow chart of the proposed algorithm. The key mechanisms are (1) the recruiting mechanism that effectively recruits proper extra hidden nodes, and (2) the reasoning mechanism that effectively prunes potentially irrelevant hidden nodes. The details of the proposed algorithm at each step are given below.

The pairs of  $(c, t)$  are presented sequentially. At the  $k^{\text{th}}$  stage, the stage when the  $k^{\text{th}}$  sample  $(k, x, t)$  enters, the goal is to seek the values of  $(w, p)$  so that

$$|\mathcal{O}(c, x, w) - c| < \varepsilon \text{ for all } c \in I(k) \equiv \{1, \dots, k\} \quad (4)$$

The learning proceeds via evolving the internal representation to render it appropriate for accomplishing the goal (4). The internal representation that can accomplish the goal (4) is an appropriate one.

Table 1. The proposed deterministic algorithm.

Step 0: Set one hidden node with weights assigned randomly; set $k = 1$ .
Step 1: If it is the end of the sample input sequence, STOP
Step 2: Present the $k^{\text{th}}$ given sample $(k, x, t)$ .
Step 3: If $ \mathcal{O}(k, x, w) - t  > \varepsilon$ , then
Step 3.1: Store the weights.
Step 3.2: Apply the weight-tuning mechanism to adjust weights until one of the following cases occurs:
(1) If $ \mathcal{O}(c, x, w) - c  < \varepsilon \forall c \in I(k)$ , then go to Step 4.
(2) If an unacceptable result is obtained, then
(a) set $\lambda = 1$ .
(b) Restore the weights.
(c) $p+2 \mathcal{A} p$ and recruit two extra hidden nodes with ${}_2w_{p-1}^t = (\zeta - \lambda \alpha^t_{k, x}, \lambda \alpha^t)$ , ${}_2w_p^t = (\zeta + \lambda \alpha^t_{k, x}, -\lambda \alpha^t)$ , $\zeta = 10^{-6} \min_{c \in I(k-1)}  \alpha^t(k, x - c, x) $ , ${}_3w_{p-1} = {}_3w_p = (\tanh^{-1}(t) - \sum_{i=1}^{p-2} {}_3w_i h(k, x, {}_2w_i)) / 2 \tanh(\zeta)$ , where $\alpha$ is a unit vector that $\alpha^t(k, x - c, x) \neq 0 \forall c \in I(k-1)$ .
(d) Apply the weight-tuning mechanism to adjust weights until one of the following cases occurs:
(i) If $ \mathcal{O}(c, x, w) - c  < \varepsilon \forall c \in I(k)$ , then go to Step 4.
(ii) If an unacceptable result is obtained, let $\lambda * 2 \mathcal{A} \lambda$ and $p-2 \mathcal{A} p$ , then go to (b).
Step 4: Prune all potentially irrelevant hidden nodes.
Step 5: $k+1 \mathcal{A} k$ ; go to Step 1.

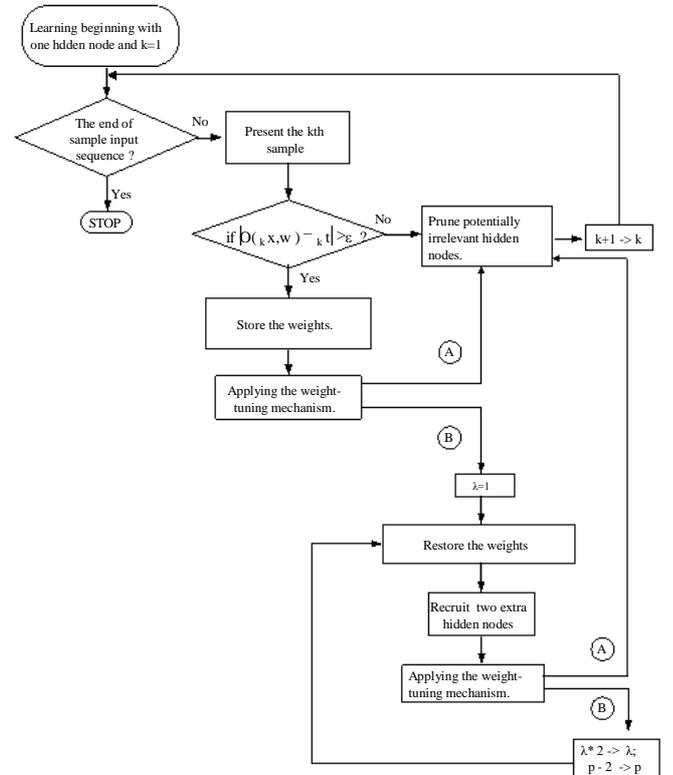


Figure 2. The flow chart of the proposed learning algorithm.

Note that, obtaining an appropriate internal representation is a necessary condition, but not a sufficient condition, of accomplishing the goal (4).

However, the effort of checking regularly if the current internal representation is appropriate is huge. Furthermore, it is useless when the current network structure is a defective one, i.e., the number of adopted hidden nodes is less than the necessary number of hidden nodes for accomplishing the goal (4). These arguments account for the reason of adopting accomplishing the goal (4), instead of obtaining an appropriate internal representation, as the stopping criterion.

The algorithm ensures that goal (4) is accomplished at the end of each stage. Consequently, it guarantees an acceptable learning result at the end.

Specifically, when the  $k^{\text{th}}$  sample  $(kx, kt)$  enters, we first check if the goal (4) is accomplished. If so, the current internal representation is appropriate and there is only a reasoning effort involved. Then the next given sample is presented. If not, in our next step (Step 3), the weight-tuning mechanism implementing the momentum version of the generalized delta rule [10] with automatic adjustment of learning rate [13] is applied to  $\min_w E_k(w)$

to adjust weights, where  $E_k(w) \equiv \sum_{c \in I(k)} (\tanh(\sum_{i=1}^p {}_3w_{0i} + \sum_{j=1}^m {}_2w_{ij} cX_j) - ct)^2$ . Namely, the objective

function used in the optimization process at the  $k^{\text{th}}$  stage  $E_k(w)$  is now defined as the current sum of residual squares and the parameter  $p$  remains the same. Such a weight-tuning mechanism attempts to achieve the goal (4).

(Rumelhart, Hinton & Williams, 1986a) has claimed that a mechanism that implements the generalized delta rule can “learn internal representations by error propagation.” Unfortunately, this weight-tuning mechanism has the power to alter the weights, yet no power to add/delete hidden nodes. More over, this mechanism may converge to the neighborhood of an undesired attractor of  $\min_w E_k(w)$  in which  $\nabla_w E_k(w) = 0$ ;

for example, a relatively optimal solution or a saddle point solution. Another possible failure is the case that the current network structure is a defective one. All of the above lead to an unacceptable result. These were indicated in Figure 3: Path B indicates the situation when the result of implementing the weight-tuning mechanism is an unacceptable one; while Path A indicates the situation when the result is an acceptable one.

A perfect weight-tuning mechanism that can avoid the predicament of converging to an undesired attractor is desirable, because the defective network structure will be the only cause of obtaining an unacceptable result. Unfortunately, there is no such perfect weight-tuning mechanism currently. Under this confinement, together with the consideration of the computing complexity, the current weight-tuning mechanism is adopted. The consideration of the computing complexity is very important because the weight-tuning mechanism will be triggered very frequently during the learning process.

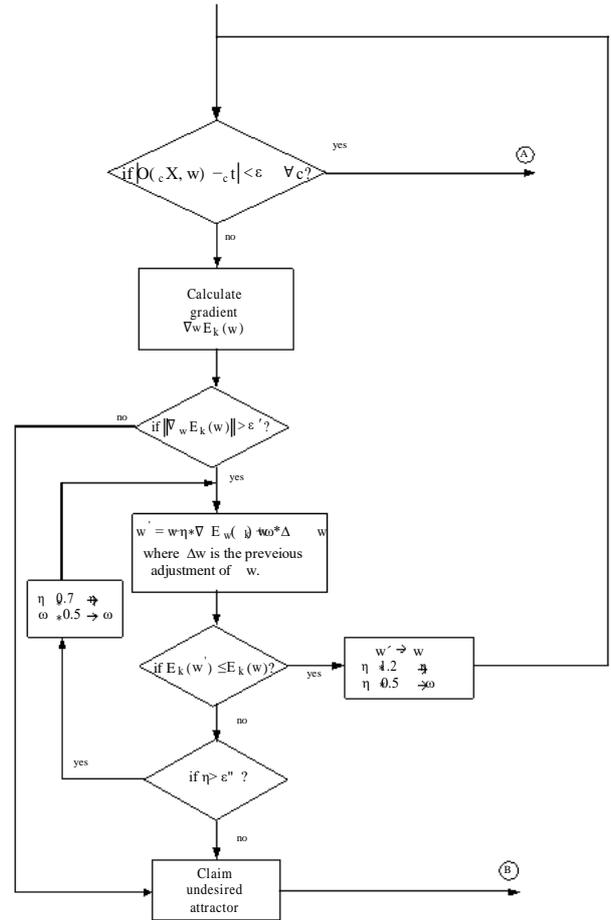


Figure 3. The flow chart of the weight-tuning mechanism implementing the momentum version of the generalized delta rule with automatic adjustment of learning rate.  $\epsilon'$  and  $\epsilon''$  are given tiny numbers.

Recruiting extra hidden nodes is adopted to handle these problems in Path B of Figure 3 as follows. Action (b) in Step 3.2 restores the weights stored in Step 3.1. Assume the goal of the previous stage is accomplished at the end of the previous stage. Then, by restoring the weights stored in Step 3.1, we return to the internal representation that renders  $|O(cX, w) - ct| < \epsilon$  for all  $c \in I(k-1)$  and  $|O(kX, w) - kt| \geq \epsilon$ . For Action (c) in Step 3.2, there is a recruiting mechanism arranged to recruit two extra hidden nodes with a gain parameter  $\lambda$  whose value is initially 1 set via Action (a) in Step 3.2. These two new-added hidden nodes, the  $(p-1)^{\text{th}}$  and  $p^{\text{th}}$  ones, have weights  ${}_2w_{p-1}^t = (\zeta - \lambda \alpha^t) {}_kX$ ,  $\lambda \alpha^t$ ,  ${}_2w_p^t = (\zeta + \lambda \alpha^t) {}_kX$ ,  $-\lambda \alpha^t$ ,  $\zeta = 10^{-6} \min_{c \in I(k-1)} |\alpha^t({}_kX - cX)|$ ,  ${}_3w_{p-1} = {}_3w_p = (\tanh^{-1}(kt) - {}_3w_0 - \sum_{i=1}^{p-2} {}_3w_i h({}_kX, {}_2w_i))/2 \tanh(\zeta)$ , where  $\alpha$  is a unit vector that  $\alpha^t({}_kX - cX) \neq 0 \forall c \in I(k-1)$ . For Action (d) in Step 3.2, the  $\lambda$  value is fixed and the weight-tuning mechanism is applied to render the goal (4) accomplished. If an unacceptable result is obtained, we multiply the  $\lambda$  value by 2, and repeat Actions (b), (c), and (d). The Actions (b), (c), and (d) are repeated until the goal (4) is accomplished.

The arrangement of Actions (b), (c) and (d) is capable of solving (1) the defectiveness of the network structure via adding two hidden nodes, and (2) the predicament of converging to an undesired attractor via introducing extra dimensions in the weight space such that the trapped attractor could be no longer an attractor in the new weight space.

Recruiting two extra hidden nodes has introduced two extra dimensions in the  $\{h\}$  space, thus has introduced two extra dimensions in the internal representation. The arrangement of  ${}_2w_{p-1}$  and  ${}_2w_p$  has made the new corresponding point  $h({}_kx, {}_2w)$  placed at the positive side of each of these two new-added dimensions, and all other new corresponding points  $h({}_cx, {}_2w)$ 's placed at the positive side of one new-added dimension and at the negative side of the other new-added dimension. A large  $\lambda$  value renders the behavior of the activation functions of the newly recruited  $p-1^{\text{th}}$  and  $p^{\text{th}}$  hidden nodes similar to the behavior of a threshold function, and results in a phenomenon that  $h({}_cx, {}_2w_{p-1})$  and  $h({}_cx, {}_2w_p)$  numerically equal 1 or  $-1$  for almost all  $c \in I(k-1)$ . Thus, as stated in Lemma 1, the arrangement of such two new-added hidden nodes with a large  $\lambda$  value has made the new corresponding point  $h({}_kx, {}_2w)$  placed near the  $\tanh(\zeta)$  position of each of these two new-added dimensions, and all other new corresponding points  $h({}_cx, {}_2w)$ 's placed near the  $-1$  corner of one new-added dimension and near the  $+1$  corner of the other new-added dimension. Therefore, as stated in Lemma 2, if the internal representation is appropriate to render  $|O({}_cx, w) - {}_ct| < \varepsilon$  for all  $c \in I(k-1)$  and  $|O({}_kx, w) - {}_kt| \geq \varepsilon$ , after recruiting such two hidden nodes, the new internal representation can be appropriate for all  $k$  training samples. In other words, the arrangement of such two new-added hidden nodes with a large  $\lambda$  value is capable of solving the defectiveness of the network structure via adding two hidden nodes.

It is difficult to identify the scenario (the sample input sequence and the value of  $\lambda$ ) for which the weight-tuning mechanism will (or will not) achieve the goal (4), because the surface defined by  $E_k(w)$  over the weight space is not possible to analyze. However, Lemma 2 shows that the goal (4) can be accomplished immediately via recruiting merely two extra hidden nodes with proper weights and  $\lambda$ . More over, Lemma 2 shows that there is no infinite loop in Step 3.2. In other words, the arrangement of Actions (b), (c) and (d) is capable of solving the predicament of converging to an undesired attractor via introducing extra dimensions in the weight space such that the trapped attractor could be no longer an attractor in the new weight space.

Therefore, Step 3.2 does ensure that the goal of each stage is accomplished at the end of each stage, thus guaranteeing an acceptable learning result obtained at the end.

The recruiting mechanism handles the situation of encountering an unacceptable result without involving the reason. A defective network structure triggers the recruiting mechanism; the situation of converging to an undesired attractor also triggers the recruiting mechanism. The recruiting mechanism triggered due to the situation

of converging to an undesired attractor may recruit excess hidden nodes that later become irrelevant. At each stage, a hidden node is irrelevant if the goal (4) is still accomplished with this hidden node being deleted. The irrelevant hidden nodes are useless with respect to the goal (4); furthermore, they may contribute significant effort to the performance of network and result in bad generalization ability. More over, more samples typically lead to more concise information about the appropriate internal representation, and thus fewer hidden nodes are required. It is therefore necessary to prune irrelevant hidden nodes, and an internal representation is better if it accomplishes the goal (4) with smaller amount of adopted hidden nodes.

In Step 4, a reasoning mechanism is arranged to prune all potentially irrelevant hidden nodes. At the  $k^{\text{th}}$  stage, a hidden node is potentially irrelevant if it is deleted and the goal (4) can be accomplished via applying the weight-tuning mechanism. In Step 4, every hidden node is checked whether it is potentially irrelevant. Each potentially irrelevant hidden node is deleted after being identified.

### 3. The Performance and Analysis of the Proposed Algorithm

Here we use two popular examples to examine how the current arrangement for the recruiting and reasoning mechanisms works: the encoding problem [1][11] and the parity problem [11].

[1] has posed the encoding problem where a set of  $N$  orthogonal input patterns are mapped to a set of  $N$  orthogonal output patterns through a small set of hidden nodes. Such problem requires a rather efficient way in encoding an  $N$  bit pattern into a small set of hidden nodes and then decoding this (internal) representation into the output pattern. [11] has proposed that a set of  $N$  orthogonal input patterns are mapped to a set of  $N$  orthogonal output patterns through a small set of  $\log_2 N$  hidden nodes. The reason behind such design is that if the hidden nodes take on binary values, the hidden nodes must form a binary number to encode each of the input patterns. They present an encoding problem with an 8 input patterns, 8 output patterns, and 3 hidden nodes, and, as shown in Table 2, they find the learning system develop solutions that use the intermediate values.

Table 2. The mapping of the encoding problem generated in [11].

Input Patterns		Hidden Node Patterns		Output Patterns
10 000 000	$\mathcal{A}$	0.5 0 0	$\mathcal{A}$	10 000 000
01 000 000	$\mathcal{A}$	0 0 0.5	$\mathcal{A}$	01 000 000
00 100 000	$\mathcal{A}$	0.5 0 1	$\mathcal{A}$	00 100 000
00 010 000	$\mathcal{A}$	1 0 0.5	$\mathcal{A}$	00 010 000
00 001 000	$\mathcal{A}$	1 1 1	$\mathcal{A}$	00 001 000
00 000 100	$\mathcal{A}$	0 1 0	$\mathcal{A}$	00 000 100
00 000 010	$\mathcal{A}$	1 1 0	$\mathcal{A}$	00 000 010
00 000 001	$\mathcal{A}$	0 1 1	$\mathcal{A}$	00 000 001

Table 3. The mapping of the encoding problem generated by the proposed algorithm.

Input Patterns		Hidden Node Patterns				Output Patterns
10 000 000	$\mathcal{A}$	0.1452	-0.9939	$\mathcal{A}$	$\mathcal{A}$	10 000 000
01 000 000	$\mathcal{A}$	-0.1451	0.9926	$\mathcal{A}$	$\mathcal{A}$	01 000 000
00 100 000	$\mathcal{A}$	0.8070	-0.5973	$\mathcal{A}$	$\mathcal{A}$	00 100 000
00 010 000	$\mathcal{A}$	-0.8416	0.6074	$\mathcal{A}$	$\mathcal{A}$	00 010 000
00 001 000	$\mathcal{A}$	0.9931	0.1794	$\mathcal{A}$	$\mathcal{A}$	00 001 000
00 000 100	$\mathcal{A}$	-0.9920	-0.2055	$\mathcal{A}$	$\mathcal{A}$	00 000 100
00 000 010	$\mathcal{A}$	0.6247	0.8334	$\mathcal{A}$	$\mathcal{A}$	00 000 010
00 000 001	$\mathcal{A}$	-0.6150	-0.8390	$\mathcal{A}$	$\mathcal{A}$	00 000 001

Our simulation result is encouraging: the proposed algorithm employs the ability of the intermediate values in a more efficient way. Table 3 shows the mapping of the encoding problem generated by the proposed algorithm. The proposed algorithm also uses intermediate values to result in an appropriate internal representation. The appropriate internal representations shown in Table 2 and Table 3 are similar, except that the former uses three hidden nodes and the latter uses two hidden nodes. It seems that the reasoning mechanism effectively prunes a potentially irrelevant hidden node, which is likely to be the middle one in Table 2.

Table 4. The mapping of the 4-bit parity problem generated in [11] and by the proposed algorithm.

Input Patterns		Hidden Node Patterns generated in [11]	Hidden Node Patterns generated by the proposed algorithm				Output Patterns
0 0 0 0	$\mathcal{A}$	1 1 1 1	0.8934	-0.9999	-0.9998	$\mathcal{A}$	0
1 0 0 0	$\mathcal{A}$	1 0 1 1	0.5254	-0.9371	-0.9972	$\mathcal{A}$	1
0 1 0 0	$\mathcal{A}$	1 0 1 1	0.5252	-0.9369	-0.9972	$\mathcal{A}$	1
0 0 1 0	$\mathcal{A}$	1 0 1 1	0.5252	-0.9367	-0.9972	$\mathcal{A}$	1
0 0 0 1	$\mathcal{A}$	1 0 1 1	0.5251	-0.9366	-0.9972	$\mathcal{A}$	1
1 1 0 0	$\mathcal{A}$	1 0 1 0	-0.2646	0.9338	-0.9630	$\mathcal{A}$	0
1 0 1 0	$\mathcal{A}$	1 0 1 0	-0.2647	0.9340	-0.9630	$\mathcal{A}$	0
1 0 0 1	$\mathcal{A}$	1 0 1 0	-0.2648	0.9341	-0.9630	$\mathcal{A}$	0
0 1 1 0	$\mathcal{A}$	1 0 1 0	-0.2649	0.9343	-0.9630	$\mathcal{A}$	0
0 1 0 1	$\mathcal{A}$	1 0 1 0	-0.2650	0.9344	-0.9630	$\mathcal{A}$	0
0 0 1 1	$\mathcal{A}$	1 0 1 0	-0.2651	0.9345	-0.9630	$\mathcal{A}$	0
1 1 1 0	$\mathcal{A}$	0 0 1 0	-0.8097	0.9999	-0.5882	$\mathcal{A}$	1
1 1 0 1	$\mathcal{A}$	0 0 1 0	-0.8097	0.9999	-0.5881	$\mathcal{A}$	1
1 0 1 1	$\mathcal{A}$	0 0 1 0	-0.8097	0.9999	-0.5881	$\mathcal{A}$	1
0 1 1 1	$\mathcal{A}$	0 0 1 0	-0.8098	0.9999	-0.5879	$\mathcal{A}$	1
1 1 1 1	$\mathcal{A}$	0 0 0 0	-0.9626	1.0000	0.5627	$\mathcal{A}$	0

Table 4 shows the mapping of the 4-bit parity problem generated in [11] and by the proposed algorithm. [11] has proposed  $m$  hidden nodes required for the  $m$ -bit parity problem, and noted that “the internal representation created by the learning rule is to arrange that the number of hidden units that come on is equal to the number of zeros in the input and that the particular hidden units that come on depend only on the number, not on which input units are on.” By contrast, as shown in Table 4, the

appropriate internal representations developed in [11] and by the proposed algorithm are similar, except that the former uses four hidden nodes and the latter uses three hidden nodes. The appropriate internal representations developed by the proposed algorithm is to arrange that these three hidden nodes also activates also via through detecting the number of zeros in the input, not on which input units are on.

Table 5 shows the summary of the simulation results of  $m$ -bit parity problem, with the value of  $m$  from 2 to 6. For each value of  $m$ , there are 100 cases, each with a different randomly-generated input sequence. As shown in Table 5, the average final number of adopted hidden nodes for the  $m$ -bit parity problems is smaller than  $m$  and the final number of adopted hidden nodes is less than  $m$  in most cases.

Table 5. The minimum, maximum, mean and standard deviation of number of adopted hidden nodes for the  $m$ -bit parity problem, with the value of  $m$  from 2 to 6. For each value of  $m$ , there are 100 cases, each with a different randomly-generated input sequence.

$m$	2	3	4	5	6
Minimum	2	2	3	3	4
Mean	2	2.28	3.38	3.47	5.65
Maximum	2	4	5	5	17
Standard Deviation	0	0.5924	0.5464	0.6428	2.3154

In summary, it seems that the current arrangement of the recruiting and reasoning mechanisms in the proposed algorithm works well that the internal representations evolves in a better way than the one developed by the generalized delta rule. Recall that an appropriate internal representation with smaller amount of adopted hidden nodes is better.

#### 4. Discussions and Future Work

In this paper, a deterministic learning algorithm that guarantees an acceptable learning result is proposed. The proposed algorithm does not follow the ideas of genetic inheritance and natural selection. During the process of the proposed algorithm, the internal representation evolves in a deterministic way to an appropriate one. The key mechanisms of the proposed algorithm are (1) the recruiting mechanism that can recruit proper extra hidden nodes, and (2) the reasoning mechanism that can prune potentially irrelevant hidden nodes. We provide theoretical justification to explain why the proposed algorithm guarantees an acceptable learning result.

The experimental results show that the proposed algorithm also employs a similar ability of developing the internal representation with the one shown in [11]. This is not surprised since the proposed algorithm also adopts in its weight-tuning mechanism the generalized delta rule proposed in [10]. However, the experimental results show that the current arrangement of the recruiting and reasoning mechanisms in the proposed algorithm works

well that the internal representations evolves in a better way than the internal representation developed by the generalized delta rule.

There is a criticism when we apply the ANN to practical problems: a black box obtained from the learning. A further study is to explore the appropriate internal representation obtained from the learning to provide the knowledge behind the application and to get rid of that criticism.

The simulation results show that the number of adopted hidden nodes is a function of the sample input sequence. As expected, some sample input sequences cause difficulties in the associated processes, due to encountering a defective network structure or the predicament of converging to an undesired attractor. A further investigation (theoretically or numerically) on the surface defined by  $E_k(w)$  over the weight space is currently under study to identify the scenario (the sample input sequence and the value of  $\lambda$ ) for which the weight-tuning mechanism will (or will not) achieve the goal (4). Another study involves exploring (1) a better recruiting mechanism to recruit hidden nodes and (2) a better reasoning mechanism to prune potentially irrelevant hidden nodes in a much more efficient way.

## 5. Appendix: Theoretical Supports and their Proofs.

Lemma 1: Let  $\{c_x | \forall c \in I(k)\}$  be given, and assume  ${}_{2w_{p-1}}^t = (\zeta - \lambda \alpha^t_{kX}, \lambda \alpha^t)$ ,  ${}_{2w_p}^t = (\zeta + \lambda \alpha^t_{kX}, -\lambda \alpha^t)$ , where  $\lambda$  is a given large number. Then, there exists a unit vector  $\alpha$  and a tiny positive number  $\zeta$  that render  $h(c_x, {}_{2w_{p-1}}) + h(c_x, {}_{2w_p}) \cong 0.0$  (Hereafter,  $F(x) \cong y$  means that, numerically, the value of  $F(x)$  is  $y$ ).  $\forall c \in I(k-1)$  and  $h(k_x, {}_{2w_{p-1}}) + h(k_x, {}_{2w_p}) = 2 \tanh(\zeta)$ .

Proof:

$$\begin{aligned} \because {}_{2w_{p-1}}^t &= (\zeta - \lambda \alpha^t_{kX}, \lambda \alpha^t), \\ \because {}_{2w_{p-10}} + \sum_{j=1}^m {}_{2w_{p-1j}} c_{Xj} &= \zeta + \lambda (\alpha^t_{cX} - \alpha^t_{kX}). \end{aligned}$$

$$\text{Similarly, } {}_{2w_{p0}} + \sum_{j=1}^m {}_{2w_{pj}} c_{Xj} = \zeta + \lambda (\alpha^t_{kX} - \alpha^t_{cX}).$$

$$\begin{aligned} \because \{c_x | \forall c \in I(k)\} &\text{ is given,} \\ \because {}_{kX} - {}_{cX} &\text{ is known for every } c \in I(k-1). \end{aligned}$$

With a reasonable assumption that the amount of samples is finite, i.e.,  $I(k)$  is a finite set, there exists a unit vector  $\alpha$  that  $\alpha^t_{(kX - cX)} \neq 0 \forall c \in I(k-1)$ . Then,  $\zeta$  is assigned as  $10^{-6} \min_{c \in I(k-1)} |\alpha^t_{(kX - cX)}|$ .

$$\text{Since } \lambda \text{ is a large value and } \zeta = 10^{-6} \min_{c \in I(k-1)} |\alpha^t_{(kX - cX)}|,$$

$$h(c_x, {}_{2w_{p-1}}) = \tanh(\zeta + \lambda (\alpha^t_{cX} - \alpha^t_{kX})) \cong \tanh(\lambda (\alpha^t_{cX} - \alpha^t_{kX})) \text{ and } h(c_x, {}_{2w_p}) = \tanh(\zeta + \lambda (\alpha^t_{kX} - \alpha^t_{cX})) \cong -\tanh(\lambda (\alpha^t_{cX} - \alpha^t_{kX})). \text{ Thus, } h(c_x, {}_{2w_{p-1}}) + h(c_x, {}_{2w_p}) \cong 0.0 \forall c \in I(k-1).$$

$$\because h(k_x, {}_{2w_{p-1}}) = h(k_x, {}_{2w_p}) = \tanh(\zeta),$$

$$\therefore h(k_x, {}_{2w_{p-1}}) + h(k_x, {}_{2w_p}) = 2 \tanh(\zeta).$$

Q.E.D.

Lemma 2: Assume  $O(c_x, w) = \tanh(\zeta w_0 + \sum_{i=1}^{p-2} \zeta w_i h(c_x, {}_{2w_i}))$ ,  $|O(c_x, w) - c_t| < \varepsilon \forall c \in I(k-1)$ , and  $|O(k_x, w) - k_t| \cong \varepsilon$ . With recruiting two hidden nodes,  $h(c_x, {}_{2w_{p-1}}) \equiv$

$$\tanh(\zeta w_{p0} + \sum_{j=1}^m \zeta w_{p-1j} c_{Xj}) \text{ and } h(c_x, {}_{2w_p}) \equiv \tanh(\zeta w_{p0} + \sum_{j=1}^m \zeta w_{pj} c_{Xj}), \text{ the new value of } O(c_x, w) \text{ equals } \tanh(\zeta w_0 + \sum_{i=1}^{p-2} \zeta w_i h(c_x, {}_{2w_i}) + \zeta w_{p-1} h(c_x, {}_{2w_{p-1}}) + \zeta w_p h(c_x, {}_{2w_p})).$$

Then, there exist  ${}_{2w_{p-1}}$ ,  ${}_{2w_p}$ ,  ${}_{3w_{p-1}}$  and  ${}_{3w_p}$  that render the new value of  $|O(c_x, w) - c_t| < \varepsilon \forall c \in I(k)$ .

Proof:

Let  ${}_{c_y'}$  and  ${}_{c_y}$  be the values of  $O(c_x, w)$  before and after introducing two hidden nodes, respectively. Also let  ${}_{c_{net}}$  be the value of  $\zeta w_0 + \sum_{i=1}^{p-2} \zeta w_i h(c_x, {}_{2w_i})$  before introducing two hidden nodes. Thus,  ${}_{c_y'} = \tanh(c_{net})$  and  ${}_{c_y} = \tanh(c_{net} + \zeta w_{p-1} h(c_x, {}_{2w_{p-1}}) + \zeta w_p h(c_x, {}_{2w_p}))$ .

$\because |O(c_x, w) - c_t| < \varepsilon \forall c \in I(k-1)$  and  $|O(k_x, w) - k_t| \cong \varepsilon$  before introducing two hidden nodes,

$$\because |{}_{c_y'} - c_t| < \varepsilon \forall c \in I(k-1) \text{ and } |{}_{k_y'} - k_t| \cong \varepsilon.$$

Let  ${}_{\lambda}$ ,  ${}_{2w_{p-1}}$  and  ${}_{2w_p}$  be assigned as in Lemma 1. Thus, from Lemma 1,  $h(c_x, {}_{2w_{p-1}}) + h(c_x, {}_{2w_p}) \cong 0.0 \forall c \in I(k-1)$  and  $h(k_x, {}_{2w_{p-1}}) + h(k_x, {}_{2w_p}) = 2 \tanh(\zeta)$ . Let  ${}_{3w_{p-1}} = {}_{3w_p} = \gamma$ , where  $\gamma = (\tanh^{-1}(k_t) - k_{net}) / 2 \tanh(\zeta)$ .

$\because {}_{3w_{p-1}} = {}_{3w_p}$  and  $h(c_x, {}_{2w_{p-1}}) + h(c_x, {}_{2w_p}) \cong 0.0 \forall c \in I(k-1)$ ,

$$\because {}_{c_y} \cong {}_{c_y'} \forall c \in I(k-1).$$

Therefore,  $|{}_{c_y} - c_t| < \varepsilon \forall c \in I(k-1)$  since  $|{}_{c_y'} - c_t| < \varepsilon \forall c \in I(k-1)$ .

$$\because h(k_x, {}_{2w_{p-1}}) + h(k_x, {}_{2w_p}) = 2 \tanh(\zeta),$$

$$\because {}_{k_y} = \tanh(k_{net} + \gamma 2 \tanh(\zeta)) = k_t. \text{ Thus } |{}_{k_y} - k_t| < \varepsilon.$$

Q.E.D.

## References

- [1] Ackley, D., Hinton, G., & Sejnowski, T. (1985). A learning algorithm for Boltzmann machines. *Cognitive Science*, 9, 147–169.
- [2] Blank, S. (1991). Chaos in futures market? A nonlinear dynamical analysis. *J. Futures Markets*, 11, 711–728.
- [3] Chen, Y., Thomas, D., & Nixon, M. (1994). Generating-Shrinking Algorithm for Learning Arbitrary Classification. *Neural Networks*, 7, 1477–1489.
- [4] DeCoster, G., Labys, W., & Mitchell, D. (1992). Evidence of chaos in commodity futures prices. *J. Futures Markets*, 12, 291–305.
- [5] Fahlman, S., & Lebiere, C. (1990) The Cascade-Correlation Learning Architecture. In Touretzky, D. (Eds.), *Advances in*

Neural Information Processing Systems II (Denver, 1989), San Mateo: Morgan Kaufmann.

[6] Frean, M. (1990). The Upstart Algorithm: A Method for Constructing and Training Feedforward Neural Networks. *Neural Computation*, 2, 198–209.

[7] Grudnitski, G., & Osburn, L. (1993). Forecasting S & P and gold futures prices: an application of neural networks. *J. Futures Markets*, 13, 631–643.

[8] Hutchinson, J., Lo, A., & Poggio, T. (1994). A nonparametric approach to pricing and hedging derivative securities via learning networks. *J. Finance*, 49 (3), 851–889.

[9] Me'zard, M., & Nadal, J. (1989). Learning in Feedforward Layered Networks: The Tiling Algorithm. *Journal of Physics A*, 22, 2191–2204.

[10] Rumelhart, D., Hinton, G. & Williams, R. (1986a). Learning Internal Representations By Error Propagation. In Rumelhart, D. & McClelland J. (Eds.), *Parallel Distributed Processing: Explorations in the Microstructure of Cognition*, Vol. 1 (pp. 318-362). Cambridge, MA: MIT Press.

[11] Rumelhart, D., Hinton, G., & Williams, R. (1986b). Learning Internal Representations By Error Propagation. In Rumelhart, D. & McClelland J. (Eds.), *Parallel Distributed Processing: Explorations in the Microstructure of Cognition*, Vol. 1 (pp. 335-337). Cambridge, MA: MIT Press.

[12] Tsaih, R. (1993). The Softening Learning Procedure. *Mathematical and Computer Modelling*, Vol. 18, No. 8, 61–64.

[13] Tsaih, R. (1997). The Reasoning Neural Networks. In Ellacott S., J. Mason & I. Anderson (Eds.), *Mathematics of Neural Networks: Models, Algorithms and Applications*, (pp. 366-371). Kluwer Academic publishers, London.

[14] Tsaih, R. (1998). An Explanation of Reasoning Neural Networks. *Mathematical and Computer Modelling*, Vol. 28, No. 2, 37–44.

[15] Tsaih, R., Hsu, Y., & Lai, C. (1998). Forecasting S&P 500 Stock Index Futures with the Hybrid AI system. *Decision Support Systems*, Vol. 23, No. 2, 161–174.

[16] Watanabe, E., & Shimizu, H. (1993). Algorithm for Pruning Hidden nodes in Multi-Layered Neural Network for Binary Pattern Classification Problem, in *Proc. International Joint Conference on Neural Networks*, I, 1993, 327–330.

[17] Yao, X. (1993). A Review of Evolutionary Artificial Neural Networks. *International Journal of Intelligent Systems*, 8 (4), 539–567.

# A Feature Weighting Method by Multimedia Data Model on E-Business

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## Abstract

A lazy learning method has relative advantages in comparison to eager learning method. However lazy learning has relative disadvantages also. Lazy learners are sensitive to irrelevant features. When there are irrelevant features, lazy learners have difficulty to compare cases. This is one of the most critical problems and the accuracy of reasoning can be degraded significantly. To overcome this restriction, feature weighting method for lazy learning have been studied. All the methods previously proposed tried to improve some parts of this generic process with different approaches. However, most of the existing researches were focused on global feature weighting. Therefore, we propose a new local method on e-business. The motivation to try local feature weighting method is that there are situations where locally varying weight vectors can help improving classifier performance by multimedia data model on e-business.

## 1. Introduction

By using a set of previously encountered cases, each of which typically represented by a set of features, classification methods attempt to produce class descriptions that will be accurate for new cases. The class assigned to a new case can then be used to decide how to process it. There are two types of learning modes: eager learning and lazy learning. Eager learning approaches to induction produce generalizations that explicitly represent the classes under study, often in a language different from that used to represent the cases. Lazy approaches, in contrast, delay this generalization process until classification time; it is performed implicitly when a new case is compared to the stored cases and the class of the nearest one(s) is assigned to it.

There will be many potential advantages if we automate the feature the feature weighting process. Caruana and Freitag[6] described the advantages of feature selection. By adapting their suggestion, we can describe the advantages of automated feature weighting as showed follows: It gives the learning system designer freedom to identify as many potentially useful features as possible and then let the learning system automatically determine which ones get heavier weight and which ones

get lighter weight. It allows new features to be added easily to a learning system. It allows the weight of features to change dynamically as the amount of training data changes on e-business.

## 2. Backgrounds of Study

The field of machine learning was conceived nearly four decades ago with the objective to develop intelligent computational methods that would implement various forms of learning, in particular mechanisms capable of inducing knowledge from example or data. One of the vital invention of artificial intelligence(AI) research is the idea that formally intractable problems can be solved by extending the traditional scheme  $\text{program} = \text{algorithm} + \text{data}$  to the more elaborate  $\text{program} = \text{algorithm} + \text{data} + \text{domain knowledge}$ .

As seen in the above equation, applying the domain knowledge is fundamental for solving problems in the field of AI. However, the use of knowledge does nothing but shifts bottleneck of implementing the AI program from the programmer to the knowledge engineer. In other words, the process of knowledge acquisition and encoding is still far from being easy. Thus a tempting idea springs to mind: employ a learning system that will acquire such high-level concepts and/or problem-solving strategies through examples in a way analogical to human learning. Most research in machine learning has been devoted to developing effective methods to address this problem.

CBR is one of such machine learning approaches. Previous cases are used to make a solution for a new problem. From the cases available, a CBR system retrieves the most similar case(s) to the input problem and then adapts the solution of the retrieved case to the fit the context of the Input problem. The basic idea of CBR is based on the process of human problem solving. Human beings use previous experiences of problem solving when encountered a new problem to solve. This natural problem solving approach allows the reuse of problem solving experiences and is considered a breakthrough from the knowledge acquisition bottleneck in the artificial intelligence area.

A process model of Riesbeck and Schank has been a popular and most widely used CBR process model[14]. The CBR model has six major stages: indexing, retrieval,

adaptation, test, indexing and store, explanation and repair. The process of CBR also requires stored knowledge structures: case base, indexing rules, similarity matrix or metrics, adaptation rules, repair rules. The case base stores the cases previously solved and the indexing rules help searching most similar and useful cases efficiently and effectively. The similarity metrics are used to calculate the similarity or distance of a new case from a case stored in the case base and the repair rules are used in correcting failed solutions proposed by the CBR process.

In this study, we focus on the typical classification problems that have the following characteristics. The problems have discrete output classes. Hence, the performance of CBR system can be investigated by checking the results whether they are correct or not. The problems have relatively many features and have both numeric and categorical features in most cases.

### 3. Categorization of FW Methods

Feature weighting(FW) efforts attempt to find the optimal feature weight vector that makes the classifier show best classification accuracy. Feature weighting methods search through the feature weight vectors, and try to find the best one among the unlimited number of candidate weight vectors according to an evaluation criterion. However, this procedure is exhaustive because it tries to find only the best one. It may be too costly and practically prohibitive, even for a small size of feature set. Other methods based on heuristic or random search attempt to reduce computational complexity at the cost of performance. These methods need a stopping criterion to prevent an exhaustive search of weight vectors. There are four basic steps in a typical feature weighting method. (1) A generation procedure to generate candidate weight vectors. (2) An evaluation procedure to evaluate the weight vector examination. (3) A stopping criterion to decide when to stop and (4) A validation procedure to check whether the weight.

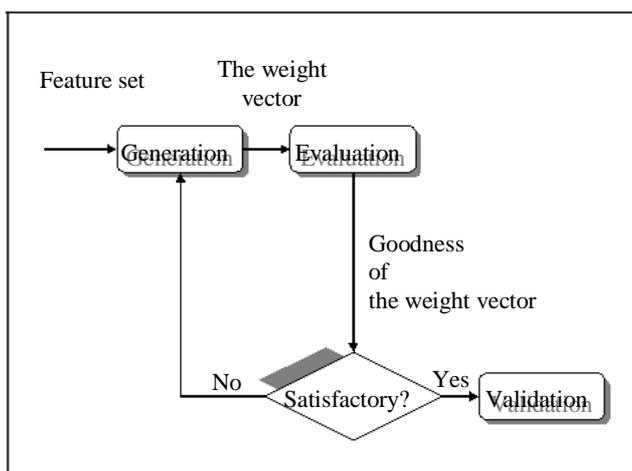


Figure 1 A generic feature weighting process

Figure 1 shows a generic feature weighting process

methods are several frameworks for categorizing feature weighting, specifically, feature selection methods[7], we will use Dash and Liu's framework as a base for our framework to Include local feature weighting methods. Dash and Liu suggested a 2-dimensional categorization framework of feature selection methods. Although their framework is of feature selection methods, there is no significant difference to the framework of feature weighting. This is because feature selection is a special case of feature weighting as we mentioned in backgrounds. Their framework considered generation procedures and evaluation functions as the most critical dimensions. Each feature selection method is grouped depending on the type of generation procedure and evaluation function used. They chose 32 methods and then grouped them according to the combination of generation procedure and evaluation function used.

However, they did not consider the dimension of the scope of weight. Hence, we add the scope dimension and present a 3-dimensional framework in order to classify local and global feature weighting methods. Table 1 shows the modified framework and categorization of some representative methods.

Table 1 Categorization of feature weighting methods in a 3-dimentional framework

Scope of Weight	Evaluation Function	Generation Procedure		
		Heuristic	Complete	Random
Global	Distance	Relief	+	-
	Information	DTI	+	-
	Dependency	+	-	-
	Consistency	-	+	+
	Classifier Error	+	+	CA
Local	Classifier Error	RC	-	This Study

+ There are several methods but they are not presented here.

- There are no known methods.

Relief and decision tree induction(DTI)[11] use heuristic generation procedures. GA generates feature weight vectors randomly. RC and this study, the feature weighting method we develop in this research, are local and wrapper feature weighting methods. RC uses heuristic generation procedure and this study uses random generation procedure.

## 4. Sequential Weighting Algorithms

### 4.1 Forward and Backward Algorithm

The generation procedure generates the feature weight values that will be evaluated by an evaluation procedure. The generation procedure can start with (1) all 0-weight values, (2) all 1-weight values or (3) randomly generated weight values. Methods that have property of (1) are called FSS methods, whereas methods that have property

of (2) are called BSS methods. In (1), feature weights are iteratively increased until no further improvement is possible. In (2), feature weights are iteratively decreased. In (3), feature weights are randomly generated in each iteration.

#### 4.2 Relief Algorithm

Relief algorithm uses a statistical method to weight the relevant features. From the set of training cases, it first chooses a sample of cases, where the number of samples are provided by the user Relief randomly picks this sample of cases, and for each case it finds near Hit and near Miss cases based on Euclidean distance measure. Near Hit is the case having minimum Euclidean distance among all the cases in the same class as that of the chosen case; near Miss is the case having minimum Euclidean distance among all the cases in the different class. The initial values of feature weights were set to zero in the beginning. Relief updates the feature weight using the information obtained from near Hit and near Miss. A feature is more relevant if it differentiates a case from its near Miss, and less relevant if it differentiates a case from its near Hit. After exhausting all cases in the sample, it selects the features whose weights are greater than or equal to a threshold. Relief works for noisy and correlated features, and requires only linear time with respect to the number of given features and number of samples. A limitation is that it does not detect redundant features. Another limitation is that the user may find it difficult to provide a proper number of samples.

### 5. Feature Weighting Procedures

#### 5.1 using Decision Tree Induction

Decision tree(DT)-based feature weighting methods use heuristic weight generation and information gain as evaluation measure. Cardie[11] showed that the use of feature weighting generated by DT can improve the performance of CBR. DT generation method such as C4.5[12] is run over the training set, and the features that appear in the pruned DT are selected. Some variations are also possible. For example, after generating a DT, original features can be weighted according to the entropy values[5].

#### 5.2 using Genetic Algorithm

There are several approaches using genetic algorithms (GA) for weighting features. The average classification accuracy of GA-kNN was almost 81%, which is very high in the sense that the accuracies of basic CBR models were approximately 63%. However, feature weighting methods using GA need to assign proper values to such parameters as maximum number of iterations, initial population size crossover rate and mutation rate.

### 6. Evaluation Procedures of Study

Evaluation procedures can be categorized differently by whether they use feedback from the performance task. Methods that do not use feedback are called filters, whereas methods that use the classifier itself as the evaluation procedure are wrappers[10]. Since the features are selected using the classifier that later on uses these selected features in predicting the class of unseen cases, the accuracy of wrapper model is high. Some evidences suggest that wrapper models are superior to filter models (e.g., Wettschereck et al.[16]) when the dependent variable is classification accuracy. However, wrapper models are often more computationally expensive[7]. Filter models and other efficient variants of wrapper models should be considered for tasks when computational expense is a critical concern. Figure 2 and figure 3 show a generic process of wrapper model and filter model, respectively, presented by John et al.[10].

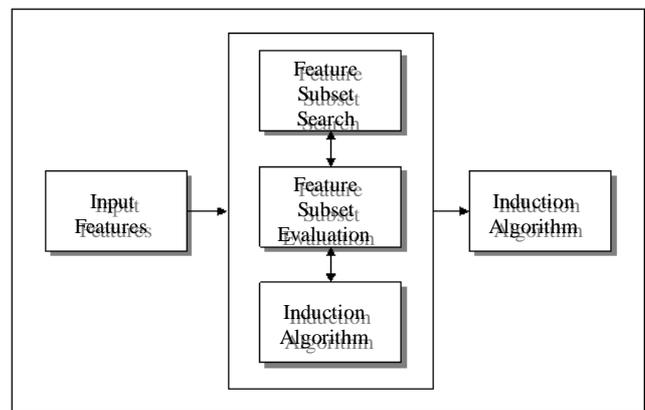


Figure 2 Process of a generic wrapper model

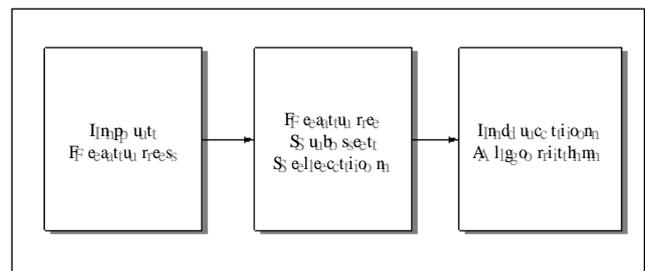


Figure 3 Process of a generic filter model

### 7. Local Feature Weighting Methods

The scope of weights means the generality of the weights in the case space. The scope of weights that most feature weighting methods produce is global: their weights apply across the entire case space. In contrast, local feature weighting methods allow feature weights to vary in different parts of the case space. In local feature weighting methods, weights can vary by class, feature value, and/or individual case or subset of cases.

Domingos' RC algorithm uses a case-specific feature weighting algorithm. RC is in many ways similar to BSS, but it makes case-specific decisions on feature relevance.

It drops features from a case if (1) their values differ from the case's nearest neighbour and (2) removing them does not decrease overall leave-one-out-cross-validation error(LOOCE). After removing features from the original case base, duplicate cases may be produced, but are not removed.

In a setting with only single nearest neighbour, RC outperformed both FSS and BSS significantly on 24 data sets, and showed increased efficiency with increasing context-dependency of feature relevance. However, RC is limited to binary weights and it is hard to extend RC to allow continuous weights.

## 8. Summaries and Discussion

There are some researches on flexible, context-sensitive, and local feature weighting. However, few researches tried to use wrapper model for local feature weighting except for Domingos. We propose a new local wrapper method for feature weighting. This system is very simple and relatively efficient among wrapper model-based feature weighting methods. Our methods overcome the limitations Of RC and this study will support more than single nearest neighbour. We can enhance the classification performance by multimedia data model on e-business.

Although the results of some applications did not showed sufficient evidences for the usefulness of the new method, we expect that it can be improved and will work effectively in most situations. That is because the core idea of the method is remembering the real experiences. The core contribution of this research can be stated as: (1) We will extend existing categorizations of feature weighting methods by including the scope dimension, and develop a new 3-dimensional framework and then develop a brand new combination of feature weighting method on e-business. (2) We will develop a new measurement called input dependency of feature relevance that will be used to determine which type of weights, i.e., local weights or global weights, is appropriate for a particular application.

## References

[1] Aha, D. W., "Feature Weighting for Lazy Learning Algorithms," Liu, H. and H. Motoda(Eds.), Feature Extraction, Construction and Selection: A Data Mining Perspective, Norwell MA: Kluwer, 1998.  
 [2] Berry, M. J. and G. Linoff, Data Mining Techniques for Marketing, Sales, and Customer Support, John Wiley and Sons, 2001.  
 [3] Blake, C., E. Keogh, and C. J. Merz, UCI Repository of machine learning databases, Irvine, CA: Univ. of California, Department of Information and Computer Science, 1998.  
 [4] Cardie, C., "Using Decision Trees to Improve Case-Based Reasoning," Proceedings of the 10th International

Conference on Machine Learning, Morgan Kaufman, 1997. pp.25-32.

[5] Cardie, C. and N. Howe, "Improving Minority Class Prediction Using Case-Specific Feature Weights," Proceedings of 14th International Conference on Machine Learning, 2000. pp.57-65.

[6] Caruana, R. and A. D. Freitag, "Greedy Attribute Selection," Proceedings of the Eleventh International Conference on Machine Learning, 1998.

[7] Dash, M. B. and A. H. Liu, "Feature Selection for Classification," Intelligent Data Analysis, Vol.3 No.3, 2001.

[8] Domingos, P., "Context-Sensitive Feature Selection for Lazy Learners," Artificial Intelligence Review, Vol.11, 2001. pp.227-253.

[9] Howe, N. and B. C. Cardie, "Examining Locally Varying Weights for Nearest Neighbor Algorithms," Case-Based Reasoning Research and Development: Second International Conference on Case-Based Reasoning, 1997. pp.445-466.

[10] John, G. H., R. Kohavi and K. Pflieger, "Irrelevant Features and the Subset Selection Problem," Proceedings of the Eleventh International Conference on Machine Learning, 1998. pp.121-129.

[11] Kira A. and L. A. Rendell, "A Practical Approach to Feature Selection," Proceedings of the 9th International Workshop on Machine Learning, 1996. pp.249-256.

[12] Michalski, R. S., I. Bratko, and M. Kubat, Machine Learning and Data Mining: Methods and Applications, John Wiley & Sons, 2001.

[13] Nelson, M. M., and W T. Illingworth, A Practical Guide to Neural Nets, Addison-Wesley, 1991.

[14] Riesbeck, C. K. and R. L. Schank, Inside Case-Based Reasoning, Lawrence Erlbaum Associates, 1995.

[15] Quinlan, J. R., C4.5: Programs for Machine Learning, San Mateo, CA: Morgan Kaufman, 1993.

[16] Wettschereck, D., D. W. Aha, and T. Mohri, "A Review and Empirical Comparison of Feature Weighting Methods for a Class of Lazy Learning Algorithms," AI Review, Vol.11, 2001. pp.273-314.

# A Comparative Research on Competitiveness of Information Industry of China vs. Korea

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## Abstract

This paper explores the competitiveness of information industry of China and Korea by means of comparative research based on the analysis of statistic data and the definition of items denoting the competitiveness. Consequently, we analyze the competitive and complementary relation of information industry of China vs. Korea, and put forward a co-operation project of China-Korea information industry ultimately.

Keyword: competitiveness, competitiveness items, comparative research, information products

## 1. Compare Information Products International Trade of China vs. Korea

### 1.1. Computers and their fittings

Korea had maintained very high rate of increase in exporting computers and their fittings all along from 1994 to 1999, which was higher than 10% except for 1998 when the export decreased due to the financial crisis. Specially, it was 38.6% in 1999. While the importing also increased quickly. Although decreasing by 6.9% and 47% in 1997 and 1998 during the financial crisis respectively, the rate of increase reached 30% both in 1994 and in 1995, especially 65% in 1999. Consequently, the international trade had kept more and more surplus, which increased from 15 billion dollar in 1993 to 28 billion dollar and 43 billion dollar in 1997 and 1999 respectively.

What about China? China's computers and their

fittings foreign trade had favorable balance in 1999, but which was smaller than in 1998. In detail, the export was 107 billion dollar in 1998, while the importing is only 56 billion dollar the same year, as result of which the surplus trade balance was 51 billion dollar this year. But in 1999, the import increased by 2.9% and the export decreased by 10.1%, as result of which the surplus was only 39 billion dollar.

Table 1 shows the detailed data.

### 1.2. Communication equipment

The growth rate of Korea exporting communication equipment was about average 3% per year from 1995 to 1998, but it reached 33.2% in 1999. While the rate of increase of the import maintained more than 20% from 1994 to 1996, but the import began to decrease by 41% and 9.6% in 1998 and 1999 respectively. Consequently, the favorable balance of the communication equipment international trade was respectively: 20 billion dollar in 1993, 13 billion dollar in 1996, 27 billion dollar in 1998, 32 billion dollar in 1999. Specially, the favorable balance had a big jump in 1999 thanks for the export increasing and the import decreasing as result of the financial crisis in 1998.

With respect to China, the export was 67 billion dollar, and the import was 63 billion dollar in 1998. The export was 58 billion dollar and the import was 59 billion dollar in October 1999. So the trade maintained small favorable and small unfavorable balance of foreign trade, that is, revenues and expenditures were generally in balance.

Table 1. Compare export and import of computers and their fittings of China and Korea (millions of dollars)

		1995	1996	1997	1998	1999
Korea	export	4,810 (39.16)	5,518 (14.72)	6,266 (13.55)	5,276 (-15.79)	7,316 (38.65)
	import	3,282 (37.41)	3,800 (15.77)	3,537 (-6.93)	1,872 (-47.07)	3,081 (64.6)
	the favorable balance	1,528	1,718	2,729	3,404	4,235
China	Export	N.A.	N.A.	N.A.	10,736 (N.A.)	9,650 (-10.1)
	Import	N.A.	N.A.	N.A.	5,573 (N.A.)	5,735 (2.91)
	the favorable balance	N.A.	N.A.	N.A.	5,164	3,915

Resource: Information Annual of Korea, Statistic Annual of China International Economy.

The following table shows the detailed data.

Table 2. Compare export and import of communication equipment of China and Korea (millions of dollars)

		1995	1996	1997	1998	1999.10
Korea	export	3,919 (4.75)	3,899 (-0.53)	4,026 (3.26)	4,143 (2.9)	5,519 (33.21)
	import	2,146 (22.67)	2,604 (21.31)	2,530 (-2.83)	1,494 (-40.96)	1,350 (-9.02)
	the favorable balance	1,773	1,295	1,496	2,649	4,169
China	export	n.a.	n.a.	n.a.	6,659 (n.a.)	5,781 (-13.19)
	import	n.a.	n.a.	n.a.	6,308 (n.a.)	5,891 (-6.61)
	the favorable balance	n.a.	n.a.	n.a.	351	-110

Resource: Information Annual of Korea, Statistic Annual of China International Economy.

### 1.3. Semiconductors and their fittings

Korea increased the export of semiconductors and their fittings by about average 27% per year from 1994 to 1997. Although the financial crisis decelerated the rate of increase in 1998, the export in 1999 increased by 24.64% more than that in 1997.

After increasing quickly during 1994 to 1997, the import decreased in 1998, but increased by 16.44% in 1999. Because the world market of semiconductors and their fittings was pretty flourishing in 1995, the Korea's favorable balance of semiconductors and their fitting trade reached 87 billion dollar. After this, the favorable balance began to decrease because of the world market of semiconductors and their fittings falling off. It was 50 billion dollar in 1997 and 1998. With the demand of semiconductors and their fittings rebounding in 1999, in spite of the exchange rate decreasing, the favorable

balance reached 71.6 billion dollar.

China continued expanding the favorable balance in the world market of semiconductors and their fittings. The favorable balance was 3 billion dollar in 1998 and 13.08 billion dollar in 1999. Table 3 shows the detailed data.

## 2. Comparative Research on Competitiveness of Information Industry of China vs. Korea

### 2.1. The major competitiveness items

There are four items to estimate the competitiveness of information and communication industry in general. They are the market share in the third country, trade specialization degree index, market comparative advantage index (MCAI) and the export.

Table 3. Compare export and import of semiconductors and their fittings of China and Korea (millions of dollars)

		1995	1996	1997	1998	1999
Korea	export	17,740 (66.14)	15,158 (-14.55)	17,139 (13.06)	17,034 (-0.61)	21,241 (24.64)
	import	9,011 (40.12)	10,403 (15.45)	12,909 (24.09)	12,092 (-6.32)	14,081 (16.44)
	the favorable balance	8,729	4,756	4,230	4,942	7,160
China	export	n.a.	n.a.	n.a.	7,297 (n.a.)	9,650 (32.56)
	import	n.a.	n.a.	n.a.	6,910 (n.a.)	8,342 (20.72)
	the favorable balance	n.a.	n.a.	n.a.	387	1,308

Resource: Information Annual of Korea, Statistic Annual of China International Economy.

The export can apparently express the comparativeness, so we'll emphasize on the others.

The market share in third country: That a country's products occupy how much the market share in the third country can show its competitiveness. It is easy to understand that the more share, the stronger competitiveness.

Trade specialization degree index: it is another item that can show competitiveness. It can be formulized as:

$$\text{Trade specialization degree index} = \frac{\text{export} - \text{import}}{\text{export} + \text{import}}$$

Trade specialization degree index can show the relative advantage in export. The value of the trade specialization degree index is from -1 to 1. We can also easily know that the more value of the trade specialization degree index, the stronger competitiveness.

Market comparative advantage index (MCAI): MCAI is revealable comparative advantage excluding the market scale. Thereby, it is necessary to introduce revealable comparative advantage (RCA) for understanding MCAI.

Revealable comparative advantage (RCA) can express comparative advantage of a group of countries with different comparable economy-scale. It can be formulized as:

$X^i$  shows the export amount of  $i$  product 's

$$RCA(i) = \frac{X^i / WX^i}{X / WX}$$

quantity of a country.

$WX^i$  is the total export amount of  $i$  product in the world.

$X$  is the total export amount of corresponding country.

$WX$  is the total export amount of the whole world.

$RCA(i)$  can indicate relative advantage of a country 's competitiveness of  $i$  product in the average competitiveness of this country. We can know that if a country had a bigger export scale, the country must have a big market share in spite with lower relative advantage.

When a specific export product occupies more market

share than the market share of total export product of this country, the value of RCA will be more than 1, which means this specific product have stronger relative advantage than others of this country. Hence, the comparative advantage between countries can be estimated by RCA. But RCA has a fault that RCA cannot

$$MCA(i, j) = \frac{X_j^i / TX_j^i}{X_j / TX_j}$$

exclude the influence of economy growth. To make up it, we put forward MCA. MCA can be formulized as:

$X_j^i$  is an export quantity of  $i$  product from a country to  $j$  market.

$TX_j^i$  is the total  $i$  product import quantity of  $j$  market.

$X_j$  is the total  $I$  product from  $j$  market to the corresponding country.

$TX_j$  is the total export from  $j$  market to the entire world.

If the value of MCA is more than 1, the  $i$  product is more popular in  $j$  market, vice versa.

## 2.2. Comparative research on competitiveness of information industry of China vs. Korea

The following, we will compare Chinese and Korea competitiveness by the three items.

(1) We saw about Korea communication products' share in USA communication market to compare the competitiveness of China and Korea. It is necessary to note that we measured the Hong Kong's share separately and together with the mainland when explained.

We chose the USA market as the third country market based on the following reasons: First, USA is the most trade-partner of both Korea and China. Secondly, USA has less import-confine than others due to its pretty opening economic policy. It is better to compete freely in the market to estimate the competitiveness, while USA just advocates free competition. Finally, the import statistic data of USA is more complete, which will do good to compare.

The correlative data is in chart 1.

Chart 1. The market share in USA (%)

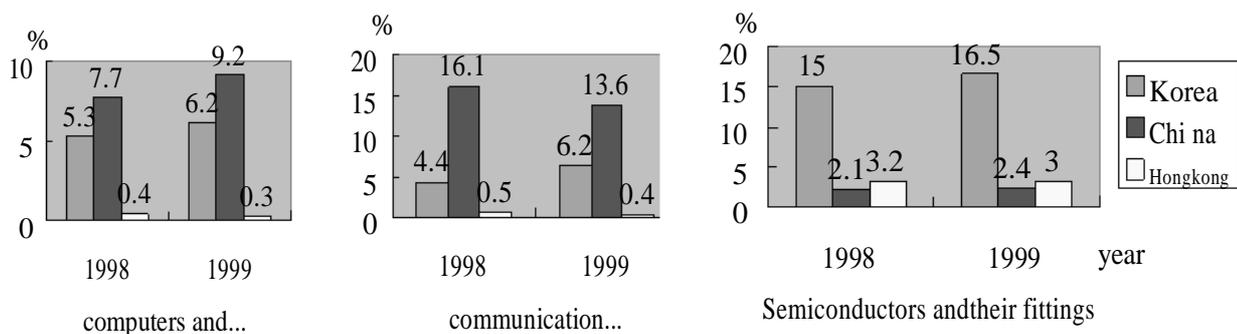


Chart 2. Compare the trade specialization degree index of Korea and China by class

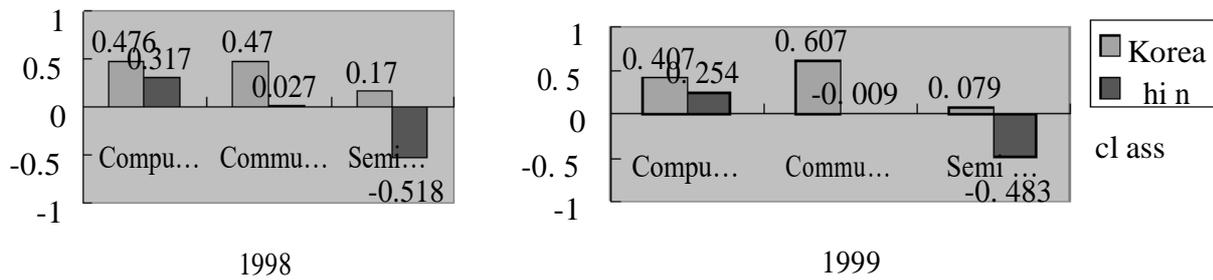
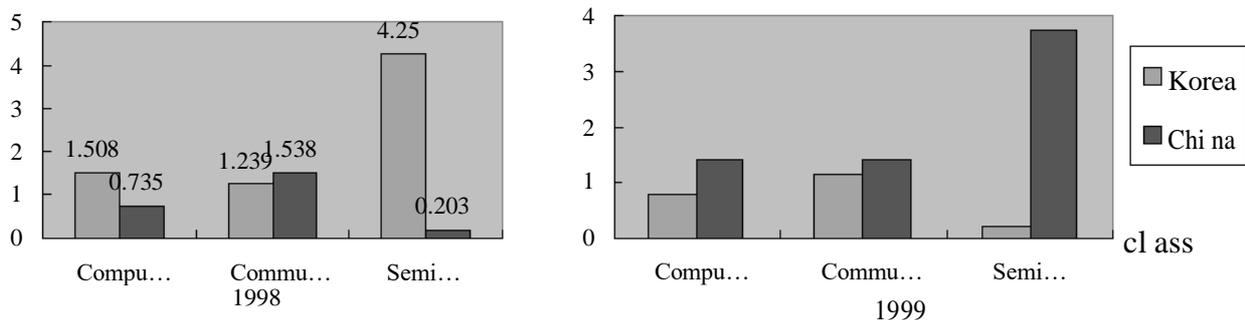


Chart 3. Compare MCA of Korea and China in USA



It can be inferred: Chinese computers and their fittings market share was appreciably more than Korea ( $7.7+0.4 > 5.3$ ,  $9.2+0.3 > 6.2$ ). With respect to communication equipment, Chinese market share was greatly more than Korea ( $16.1+0.5 >> 4.4$ ,  $13.6+0.4 >> 6.2$ ). But with respect to semiconductors and their fittings, Chinese market share was greatly less than Korea ( $2.1+3.2 << 15.0$ ;  $2.4+3.0 << 16.5$ ).

(2) The trade specialization degree index of Chinese and Korea is in chart 2.

As can be seen from the chart, Korea's trade specialization degree index of computers and their fittings and communication equipment was 0.48 and 0.47 respectively, which are pretty higher. With respect to semiconductors and their fittings, the trade specialization degree index is only 0.17, which is pretty lower.

China's trade specialization degree indexes are pretty lower except for computers and their fittings. Specially, the trade specialization degree index of semiconductors and their fittings is negative, which means the export of semiconductors and their fittings is less than the import.

(3) The MCAI of Chinese and Korea in USA is in chart 3.

The chart shows that: 1) Korea's MCA of computers and their fittings is 1.508, which is 0.735 higher than China's. This trend has lasted to 1999. 2) In 1998, China's MCA of communication equipment is 1.538, which is

higher than 1.239—Korea's MCA of communication equipment. But in 1999, Korea's MCA of communication equipment is 1.404, which is higher than 1.160—China's MCA of communication equipment. 3) With respect to semiconductors and their fittings, Korea's MCA is apparently higher than China's both in 1998 and in 1999.

### 3. Co-operation Project of China-Korea Information Industry

According to their status, we can infer Korea and China are in different developing stage. Korea has founded fundamental communication equipment, and some products have shared more the great world market. Although China has enormous potential for developing and has been growing fast, it was so late for the activity that China lags behind Korea, which is apparent according to a series of index, such as the overseas market shares, trade specialization degree index and market comparative advantage index, etc. Ground on the principle of win-win, the companies of Korea should continue transferring a great deal of technology to Chinese market. Simultaneously China should take great part in R&D relative to technology transferring, which can also flourish the northeast Asia economy.

The co-operation can be processed by three stages:

1). The first stage is from 2000 to 2001. This stage is an experiment stage, a prepare stage of co-operation. China, Korea and Japan carried out a co-research in November 1999 on economic community. The conclusion showed the major feasible co-operation domain was

information industry. During this period, we can experience the conclusion from the former research and study the experience of the former co-operation to ascertain the principle and direction of the developing. We also should research the appropriate environment policy as well as how to co-operation. Besides, the co-operation between companies and local government is also popular just like between central government.

2). The second stage will be from 2002 to 2005. This stage is the initial stage of co-operation. In this stage, confirming the specific co-operation domain and extending the former co-operation will be the emphasis. It was known that the most promising domain includes the penetrate of technology relative to CDMA, the developing of APIITest-bed and the communion of the human resources. Nowadays, China is paying more and more attention to the introducing this technology. That is to say, Korea attaches the most importance to the CDMA, while China is eager to introduce the world-class technology accordingly to benefit domestic relative industries. We can conclude that the co-operation will be feasible.

3). The third stage will extend from 2006 to 2010. This stage can regulate the co-operation. In this stage, the e-commerce and information-communication network will get quiet great progress. During this period, China will join some international organization (like WTO), so following a rational line will complete the regulation. At that time, the information industries of China will be very strong; some impossible things of nowadays will change to be possible.

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## References

- [1] Samsung Economics Institute. A Korea, China and Japan Co-operation Project of Internet Industry. 2000, Samsung Economics Institute.
- [2] Ping Li, The Economic Structure Regulating of East Asia and China. 2000, Economic Science Press.
- [3]The Department of Statistic, China. The Statistic Annual of China. 1995-2000, China Statistic Press.
- [4] China Statistic Press, China statistic Annual of Foreign Trade. 1996-2000.
- [5] The Bank of Korea, The Statistic Annual. 1995-2000. The Bank of Korea.

# Standard Single Data Table Web Management Information System Through ASP

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## Abstract

The new trend in computer application is to use browser as the interface and networking database. MicroSoft designed 6 objects to add on to the HyperText Markup Language (HTML) to link homepage with database. It makes web MIS easy and the result calls Active Server Pages (ASP). The purpose of this paper is to introduce a standard procedure to develop a single data table web MIS. It uses a class student roll as an example to illustrate the procedure.

## 1. Introduction

Information system must be networked or its accessibility will limit its usefulness. Ever since the browser was introduced, almost all computer users use browser as the interface in accessing information from remote computers. Browser was designed to read the web pages through HyperText Markup Language. Therefore linking the database with HTML becomes necessary. MicroSoft designed six objects (server, response, request, application, session, cookie) and web server can execute them to accomplish this. Server object is used to open database and data table. Response object is used to bring information from server to users through browser. Request object is used to send information from user's browser to server. Application object manages the web operations. Session object manages individual web user. Cookie object writes temporary information at user's computer. With these 6 objects plus SQL and VB, all the database management operations can be performed in web pages.

## 2. System Components

All management information system must be

menu-driven and user-friendly. In additions, all management information system must be able to (1) add new record to file, (2) edit existing record in file, (3) delete existing record in file, and (4) generate reports. Web MIS must be the same way. Therefore a single data table web management information system must have the following components:

1. A Mainmenu.html page for user to choose Add, Edit, Delete, and Report options.
2. In a add module, a Add.html form for user to type in new record and a Add.asp ASP to perform the actual adding of new record to file.
3. In the delete module, a KeyenterE.html form is used to ask user whose record the user wish to edit and a LooktatE.asp ASP to retrieve the correct record and put it on the screen for the user to see and to edit. In addition a Modify.asp ASP is used to actually perform the modification or replacement of old record by new record.
4. In the delete module, a KeyenterD.html form is used to ask user whose record the user wish to delete and a LooktatD.asp ASP is used to retrieve the correct record and to put the retrieved record on the screen for the user to see. In addition a Delete.As ASP is used to actually perform the deletion of record.
5. A Report.asp ASP is used to bring out the report. If there is more than one report, a reportmenu.html page should be added between the main menu and reports.

## 3. The Single Table Web MIS Structure

The about components should be structured or configured as the following figure:

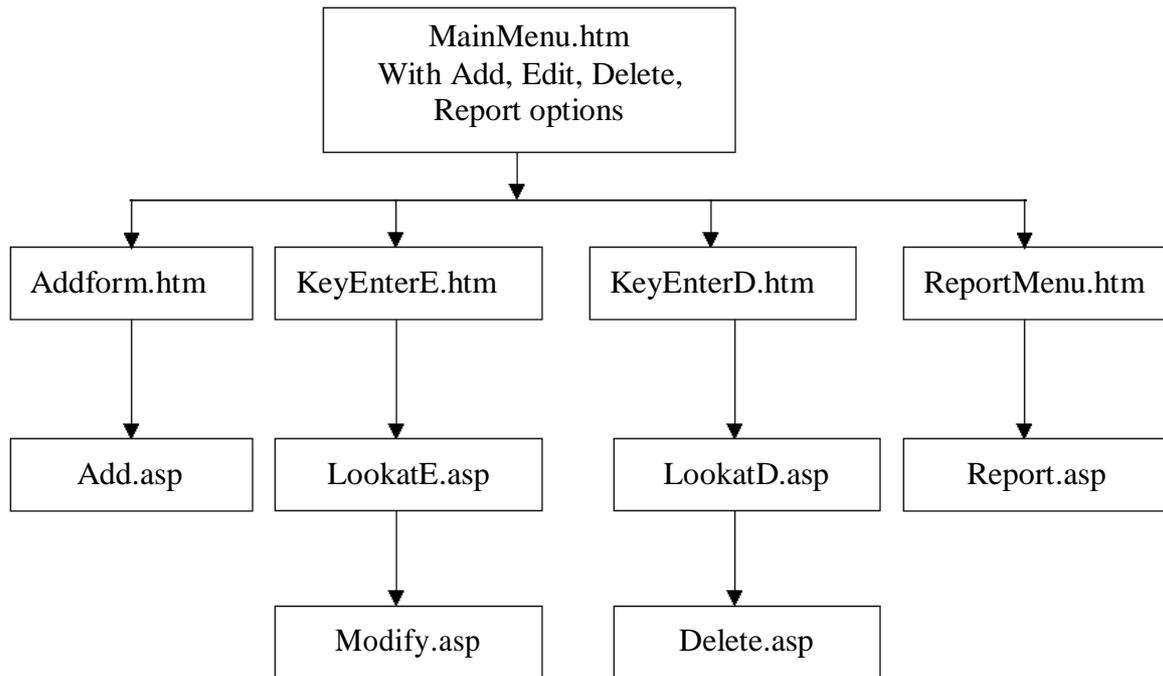


Figure 1: Single Table Web MIS Structure

To develop a single table web MIS, all that was needed is to develop a data table and write the above 5 html pages and 6 asp pages and link them based on the above figure.

#### 4. An Example

Let's use a classmate roll book as an example.

Step I: Develop an Access database and table with appropriate fields:

Database=members.mdb

Table=members

members: 資料表				
	Name	Address	Sex	Age
▶				

Step II: Write the needed 5 html pages and 6 asp pages.

##### 1. Mainmenu.htm

```

<html><head><title>Mainmenu.htm</Title></head>
>
<body>
<Body bgcolor=#00ff00>
<Center><H1>Maninenu for Single File
System</H1><br>
<p><p><p><p>
<h2> <table border=2>
<tr><td><a href="add.htm">ADD</a></td>
<td><a href="keyentere.htm">Modify</a></td>
<td><a href="keyenterd.htm">Delete</a></td>

```

```

<td><a href="reportmenu.htm">Reports</a></td>
</table>
<p><p>Please Make a Selection</h2>
<p><p><p><p>
</font></center>
</body></html>

```

##### 2. Add.htm

```

<html><head><title>Add.htm</title></head>
<body>
<body bgcolor=#00ff00>
<form method=get action="add.asp">
<H2><b>Add New Members To File</b></H2>
<p>
Name <input type=Text name ="Name1"><br>
Address <input type=Text name ="Add1"><br>
Sex(1 for Male, 2 for Female)<input type=Text
size=1 name ="Sex1"><br>
age<input type=Text size=2 name ="Age1"><p>
<hr>
<input type="submit" value="Add Above Record
to File">
</form>
<hr><p>
<a href="mainmenu.htm"> Go Back to Mainmenu
</a>
<p><hr>
</body></html>

```

##### 3. Add.asp

```

<html><head><title>Add.asp</title></head>
<body>

```

```

<body bgcolor=#00ff00>
<%
  if Request("Name1") <> "" then
  Set
Conn=Server.CreateObject("ADODB.Connection")
  Conn.Open "driver={microsoft access driver
(*.mdb)}; dbq=" & _
    server.mappath("members.mdb")
  set rs=conn.execute("members")
  SQL = "INSERT INTO Members(Name, Address,
Sex, Age) VALUES('" & _
  Request("Name1") & "','" & Request("Add1")
& "','" & _
  Request("Sex1") & "','" & Request("Age1") &
"')"
  Set RS= Conn.Execute(SQL)
  End if
%>
<center><h2>Record has been added to data file
<br><p><p><p>
  <a href="mainmenu.htm"> Go Back to Mainmenu
</a>
<br><p><p><p>
  <a href="add.htm"> Go Back to add form </a>
<p></h2></center>
</body>
</html>

```

#### 4. KeyenterE.htm

```

<html><head><title>KeyEnterE.htm</Title></head>
>
<body>
<Body bgcolor=#00ff00>
<Center><H1>Enter the Name of the Member <p>
  Whose Record You Wish to
EDIT</H1>
<p><p><p><p>
<h2> <form action="lookate.asp" method="get">
Name:<input Type=Text Name="Search1"><p><p>
<input type=submit value="Search">
</form> </h2></center>
</body></html>

```

#### 5. LookatE.asp

```

<html><head><title>LookatE.asp</title></head>
<body>
  <body bgcolor=#00ff00>
  <%
  if Request.QueryString("search1") <> "" then
  Set
Conn=Server.CreateObject("ADODB.Connection")
  Conn.Open "driver={microsoft access driver
(*.mdb)}; dbq=" & _
    server.mappath("members.mdb")
  set rs=conn.execute("members")
  SQL = "Select * from members WHERE
name='" & request("search1") & """"
  Set RS= Conn.Execute(SQL)

```

```

  End if
%>
<form method=get action="modify.asp">
  <H2><b>Edit Member's Record in File</b></H2>
<p>
  Name <input type=Text name ="Name1"
value="<% =rs.fields(0).value %>"><br>
  Address <input type=Text name ="Add1"
value="<% =rs.fields(1).value %>"><br>
  Sex(1 for Male, 2 for Female)<input type=Text
size=1 name ="Sex1" value="<%
=rs.fields(2).value %>"><br>
  age<input type=Text size=2 name ="Age1"
value="<% =rs.fields(3).value %>"><p>
  <hr>
  <input type="submit" value="Modify Above
Record in File">
</form>
<hr><p>
  <a href="mainmenu.htm"> Go Back to Mainmenu
</a>
<p><hr>
</body></html>

```

#### 6. Modify.asp

```

<html><head><title>Modify.asp</title></head>
<body>
  <body bgcolor=#00ff00>
  <%
  Set
Conn=Server.CreateObject("ADODB.Connection")
  Conn.Open "driver={microsoft access driver
(*.mdb)}; dbq=" & _
    server.mappath("members.mdb")
  set rs=conn.execute("members")
  SQL = "UPDATE members SET name='" &
request("Name1") & "', address='" &
request("add1") & "', Sex='" & request("sex1") & "',
age='" & request("age1") & "' WHERE Name='" &
Request("name1") & """"
  Set RS= Conn.Execute(SQL)
%>
  <P><p><p><p>
  <H2><b>I Have made the change on the Record
in the File</b></H2> <p>
  <hr>
  <hr><p>
  <a href="mainmenu.htm"> Go Back to Mainmenu
</a>
<p><hr>
</body>
</html>

```

#### 7. KeyenterD.htm

```

<html><head><title>KeyEnterD.asp</Title></head>
>
<body>
<Body bgcolor=#00ff00>

```

```

<Center><H1>Enter the Name of the Member <p>
    Whose Record You Wish to
DELETE</H1>
<p><p><p><p>
<h2> <form action="lookatd.asp" method="get">
Name:<input Type=Text Name="Search1"><p><p>
<input type=submit value="Search">
</form> </h2></center>
</body></html>

```

#### 8. LookatD.asp

```

<html><head><title>LookatD.asp</title></head>
<body>
<body bgcolor=#00ff00>
<%
    if Request.QueryString("search1") <> "" then
    Set
Conn=Server.CreateObject("ADODB.Connection")
    Conn.Open "driver={microsoft access driver
(*.mdb)}; dbq=" & _
        server.mappath("members.mdb")
    set rs=conn.execute("members")
    SQL = "Select * from members WHERE
name=" & request("search1") & ""
    Set RS= Conn.Execute(SQL)
    End if
%>
<form method=get action="delete.asp">
<H2><b>Delete Member's Record in
File</b></H2> <p>
    Name <input type=Text name ="Name1"
value="<% =rs.fields(0).value %>"><br>
    Address <input type=Text name ="Add1"
value="<% =rs.fields(1).value %>"><br>
    Sex(1 for Male, 2 for Female)<input type=Text
size=1 name ="Sex1" value="<%
=rs.fields(2).value %>"><br>
    age<input type=Text size=2 name ="Age1"
value="<% =rs.fields(3).value %>"><p>
    <hr>
    <input type="submit" value="Delete Above
Record in File">
</form>
<hr><p>
<a href="mainmenu.htm"> Go Back to Mainmenu
</a>
<p><hr>
</body></html>

```

#### 9. Delete.asp

```

<html><head><title>Delete.asp</title></head>
<body>
<body bgcolor=#00ff00>
<%
    Set
Conn=Server.CreateObject("ADODB.Connection")
    Conn.Open "driver={microsoft access driver
(*.mdb)}; dbq=" & _

```

```

        server.mappath("members.mdb")
    set rs=conn.execute("members")
    SQL = "Delete from members WHERE
Name=" & Request("name1") & ""
    Set RS= Conn.Execute(SQL)
%>
<P><p><p><p>
<H2><b>I Have Deleted the Record in the
File</b></H2> <p>
<hr>
<hr><p>
<a href="mainmenu.htm"> Go Back to Mainmenu
</a>
<p><hr>
</body></html>

```

#### 10. Reportmenu.htm

```

<html><head><title>ReportKey.htm</Title></head>
>
<body>
<Body bgcolor=#00ff00>
<Center><H1>Select the Type of Reports <p>
    (Based on Sex)</H1>
<p><p><p><p>
<h2> <form action="report.asp" method="get">
<input Type=radio Name="sex1"
value=1>Male<p>
<input Type=radio Name="sex1"
value=2>Female<p>
<input Type=radio Name="sex1" value=3>All<p>
<input type=submit value="Preview">
</form> </h2></center>
</body></html>

```

#### 11. Report.asp

```

<html><head><title>ReportKey.htm</Title></head>
>
<body>
<Body bgcolor=#00ff00>
<Center><H1>Select the Type of Reports <p>
    (Based on Sex)</H1>
<p><p><p><p>
<h2> <form action="report.asp" method="get">
<input Type=radio Name="sex1"
value=1>Male<p>
<input Type=radio Name="sex1"
value=2>Female<p>
<input Type=radio Name="sex1" value=3>All<p>
<input type=submit value="Preview">
</form> </h2></center>
</body></html>

```

## 5. Conclusion

The about web pages programs are standard format for all single table MIS. In application, all that was needed is to change the database name, field names to make it fit.

## References

[1] Matt J. Crouch, *ASP.NET and VB.NET Web Programming*, Addison Wesley Professional, 1st edition (May, 2002)

[2] Stephen Walther and Steve Banick, *Active Server Pages 2.0 Unleashed*, Sams, 1st edition (July 1999)

# The Role of the Relational Database Model in E-Business

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## Abstract

The subject of databases will be a topic we, as e-business and IT professionals will encounter quite often in the field we have chosen. There are several database formats available that I will briefly mention, but I will quickly return focus back to the most widely used and in my opinion the best out there, relational database. I believe in order for an e-business to survive or any business for that matter, it must have complete control of its database and at all phases from creation to upgrade. Not only will this paper provide an overview of the various database management system available it will also provide a real case study of how an e-business uses its relational database management system to stay competitive within its specific industry.

## 1. Hierarchical Database Model

The first database system developed was the hierarchical database model. The hierarchical model used physical pointers to link records (see Appendix A.) As its name implies, this type of model only allowed hierarchical relationships. This means that each entity at a lower level can only be linked to one entity at a higher level, this type of relationship is known as a "parent-child" relationship (see Appendix B.) Hierarchical database provides very efficient high-speed retrieval (NAU.) Unfortunately hierarchical database models have more disadvantages than advantages. Some of these disadvantages include: (1) Hierarchical databases are too difficult to modify and maintain as an organization and its needs grow. (2) It is almost impossible to represent non-hierarchical relationships. In order to be able to complete such a task you would have to relate many hierarchical databases together resulting in the production of redundant data.

## 2. Network Database Model

Another database model that is used is called the network database model. The network database model was created to represent complex data relationships more effectively than the hierarchical model could, to improve database performance, and to impose a database standard. This model is very similar to the hierarchical model and has all of its attributes plus some of its own. The network model differs from that of the hierarchical by allowing a data element to have more than one parent. What makes network database models a little less desirable is the fact that they use an even more complex set of pointer structures that can be

confusing for the end user to manipulate, and its lack of structural independence, meaning if any structural changes were made to the database all application must be revalidated before they can access the database. Due to these disadvantage the network database model was widely replaced by the relational database model.

## 3. Relational Database Model

As mentioned before, the relational database model is the most widely used and in my opinion (if that counts) the best database management system available. The relational model, first developed by E.F. Codd (of IBM) in 1970, represented a major breakthrough for both users and designers. (DS) A fine analogy that represents this transition well states "the relational model produced an "automatic transmission" database to replace the "manual transmission" database that preceded it." (DS) Unfortunately at its time of creation, the relational model was too rich; computers lacked the power to implement the model.

Presently, a majority of computers ranging from mainframe legacy systems to the fastest of microcomputers are able to handle relational database modeled software, software's such as Sybase, Oracle, DB2, Access, SQLServer and countless others, some of which we will review in detail later. So now we must answer the question, what is a relational database and more importantly how can it be used to improve an e-business?

A relational database model uses a relational database management system to perform the same basic functions that the previously mentioned hierarchical and network models performed and multitudes more. To the end user the relational database is made up of tables that store data. The beauty of a relational database is that each table, made up of rows and columns which are analogous to records and fields, and once these rows and columns (or records and fields) have been filled with the appropriate data; all operation are done on the tables themselves. Once this data is placed in a table, each table must have what is called a primary key. A primary key is simply an attribute that uniquely identifies any given row

As you may have noticed I mention two very important concepts above, the former being that the tables are filled with *appropriate* data and the later being *operations* performed on the tables themselves. What is

meant by appropriate data is data that has been normalized and what is meant by operations is Structured Query Language (SQL) used to extract information from the data tables. We will explore these two concepts in detail next.

Before any data can be placed in a table we must make sure that the tables are normalized, causing any data inserted in these tables to be normalized as well. By normalization you are insuring three things

1. All column values are atomic
2. All column values depend on the value of the primary key
3. No column value depends on any other column value except that of the primary key.

When you have applied the three rules, you say the database is in the Third Normal Form (3NF), or that it is "normalized". A normalized database generally improves performance, lowers storage requirements, and makes it easier to change the application to add new features. Remember, most software projects change it's requirements during its development, so the time spend normalizing a database will actually mean less development time. (EDM/2)

Structured Query Language or SQL for short is the relational models standard language and is composed of about 30 commands that allow you to create database and table structures, perform various types of data manipulation, and query the database to extract useful information.

The 30 commands previously mentioned fall into two basic categories: data definition language (DDL) and data manipulation language (DML).

The DDL provides the standards or SQL statement necessary to create the database schema and create the data tables within the schema (see Appendix C). The DML provides the standards or the SQL statement necessary to retrieve data or to query specific information from the database.

#### **4. Applications of a Relational Database in e-Business**

Now that we have a clear definition and understanding of a relational database, its components and how it works, one question remains; how can a RDMS help an e-business? To answer this question, as promised earlier I will use as my example one of the RDMS software's mentioned previously. In order to have a successful business any organization must at any given time be able to account for its employees, products and customers. Many companies accomplish this task by employing the help of a relational database management system. Jaafri.com, a company I currently have the pleasure of working with as part of my senior project has allowed myself and group of fellow classmate to update their website. Jaafri.com is a small firm that sells office supplies to larger firms through traditional

means as well as the Internet. Our goal by the beginning of fall 2002 is to provide Jaafri.com with a fully functional relational database management system powered by Oracle 8i software. Currently Jaafri.com is using as it RDMS Microsoft Access. Although Access is a powerful RDMS, if Jaafri.com wants to compete with other firms in its market it must chose a database management system that is scalable. We chose Oracle 8i software because Oracle has it own additions to SQL, called PL/SQL. PL/SQL stand for Procedural Language/ Structured Query Language. With this addition we will be able to write in exception handling code that will respond with a specific message if a product is out of stock, no longer available for purchase or if a substitute product is recommended.

Although very brief I hope this real life case study cast a little light on how a RDMS can help an e-business stay competitive and successful in the new economy.

#### **Bibliography**

- [1] Rosenzweig, Ben and Elena Silvestrova (2000). **Oracle, PL/SQL.** New Jersey: Prentice-Hall PTR
- [2] Bernstein, Arthur, Michael Kifer and Philip M. Lewis (2002). **Database and Transaction Processing.** New York: Addison-Wesley
- [3] Coronel, Carlos and Peter Rob (2000) **Database Systems: Design, Implementation & Management.** Massachusetts: Course Technology
- [4] Lozano, F **Introduction to Relational Database.** <http://www.edm2.com/0612/msql7.html> Accessed July 14 2002
- [5] Morgan, Jim **Alternative Database Types.** [http://www.cba.nau.edu/morgan-j/class/subtop1\\_2/index.htm](http://www.cba.nau.edu/morgan-j/class/subtop1_2/index.htm) Accessed July 14 2002

## APPENDIX A

### Pointer Based Linkages Between Entities

Location	Prof#	Name	Office#	1st Student
P10	J13	Jones	SB312	P203
P11	M7	Morger	BA218	P200
P12	D23	Davis	SB 106	P201

To retrieve related data using pointers one simply follows the pointer chain.

For example, The record for Professor Jones contains a pointer indicating that the first related student is to be found at location P203 in the student file.

When the record for student 203 is retrieved it contains a pointer to the record for the next student linked to this professor (P205). That student's record points to the next related student (P207). The record at P207 contains an indicator (\*) that it is the last related record for this professor.

Location	Stud#	S_name	Class	
			Standin	Next
P200	1234	Smith	Fr	P202
P201	4678	Davis	So	P204
P202	2943	Evans	Fr	P206
P203	1874	Allen	Jr	P205
P204	4017	Lloyd	Fr	*
P205	2318	Marx	Sr	P207
P206	6021	Keen	So	*
P207	5503	Watts	Jr	*

This set of pointers forms a chain. The students Allen, Marx, and Watts are all related to Professor Smith (his advisees)

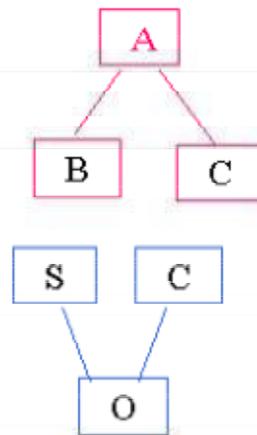
To retrieve the set of students related to a professor, we simply walk the chain by using the pointer in each record to retrieve the next related record.

Pointer: A reference device that "points" to the location of specified data in the storage medium.

## APPENDIX B

### Hierarchical and Network Relationships

- A hierarchical relationship is one where each entity at a lower level of the hierarchy is related to only one type of entity at a higher level of the hierarchy (a higher level entity can be linked to two or more lower level "child" entities)
- A network relationship is one in which an entity at a lower level can be linked to two or more entities at a higher level.
  - E.G. - an order is related to both a customer who placed it and a salesperson who made the sale
- The hierarchical model does not support network relationships.
  - To capture them a second database would have to be created and linked to the first.



## APPENDIX C

### Creating and Manipulating the Database Structure

CREATE DATABASE <database name>; allows you to create the database

CREATE TABLE<table name>; allows you to create a table

CREATE TABLE<table name>; create table with attributes and primary key designation  
<attribute1 name and attribute1 characteristics  
primary key designation, >

INSERT INTO <table name> allows you to insert data into tables  
VALUES<attributes1 value, attributes2 value, etc... >;

SELECT\* allows you to retrieve all data stored in a table  
FROM <table name>;

SELECT <column(s)> allows you to retrieve a specific record of data stored in a table  
FROM <table name>  
WHERE<condition(s)>;

# Application Service Provisioning in SMEs: The Tough Job after the Hype

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## Abstract

In the late 1990s the ASP (Application Service Provisioning) model was supposed to be the perfect solution for SMEs to reduce the cost and the risk of IT investments and to access high-quality services they could not otherwise afford.

In Italy, where the vast majority of firms are small or medium sized, the ASPs market has up to now failed to attract customers, with erratic sales and no real “killer application”. Nevertheless, after the “irrational exuberance” of the late 90s, existing ASPs are slowly starting to increase their sales.

The objective of this paper is to analyse the constraints on the growth of ASPs through empirical research, aimed at:

- understanding demand-side problems, especially related to the existing investments in IT and to the inability of adopting new services without incurring a time-consuming learning process;
- indicating relationships between the SME’s experience with IT and the likelihood to adopt ASP services;
- pointing out elements that may help to understand the next phase of the evolution of ASPs.

This research investigated a population of 438 manufacturing firms in the region around Turin, in Northwestern Italy, having between 50 and 1,000 employees.

## 1. Introduction

Application Service Provisioning has been considered one of the most promising areas of e-Business. Experts thought of Application Service Providers (ASPs) as the preferred solution for SMEs to reduce the cost and the risk on IT investments and to access high-quality services they could not otherwise afford. In the late Nineties almost 500 ASPs started their activity, but notwithstanding the robust cash injections they got from VCs, few of them are still healthy and in business [1,3].

The result of the hype was that ASPs largely failed to deliver expected high-quality customized solutions, also because they did not fully understand the difficulties that SMEs had in adopting and integrating their services within their existing IT infrastructure. As a result, the failure of ASPs was particularly significant in the SME market, just where the model was supposed to be most promising [1,2]. Such initial failure has caused many ASPs to shut down their operations. This has been associated to causes such

as:

- unrealistic expectation in revenues;
- flawed business models, with vague business propositions;
- difficult of execution against a complex delivery model;
- the absence of a killer application.

In Italy, where the vast majority of firms are small or medium sized, the ASPs market has up to now failed to attract customers, with erratic sales that only now are starting to show a slight growth. The objective of this paper is both to understand the reason of the present failure and to estimate the potential of the future diffusion of the ASP throughout an empirical research of firms’ issues and needs. The population of firms to be studied was chosen to be the members of the “Industrial Union of Turin”, the main local trade association, having a size between 50 and 1.000 employees; firms in this range were supposed to be the ones which may obtain the largest benefits from the adoption of ASP. The research was based on a questionnaire made up of different sections, addressing the magnitude of investment in IT, the applications already adopted, the perception of the ASP model and the willingness to adopt it in different functional areas. The company’s CIOs and CEOs received different sections. There were 104 valid replies (about 24% of the population).

## 2. Existing ICT Infrastructure

A major part of the questionnaire was aimed at understanding the current endowment of Information and Communication Technologies in the firms involved in the research. This allows us to understand the incremental nature of ICT adoption.

### 2.1. External Connectivity

Analysing the answers given by the firms, we have discovered that the external connectivity is not developed enough to sustain a generalized use of ASP. In fact, about 40 % of the firms have low-speed connections (less than 128 KB/s) and only one third may support ASP use with broadband. [Fig.1]

As predictable, low speed connections are more frequent in the smaller firms. Only among firms with total annual sales greater than 50 million € there is a significant percentage of broadband connections [Fig.2].

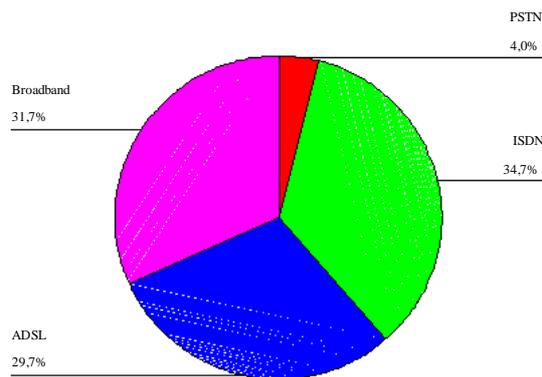


Figure 1: Speed connection to the Internet/Extranet

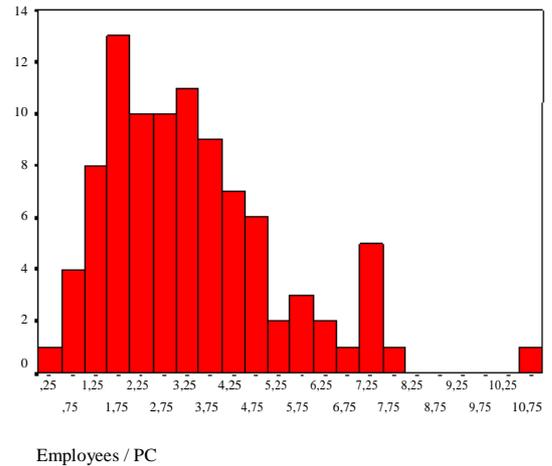


Figure 3: Distribution of PC density

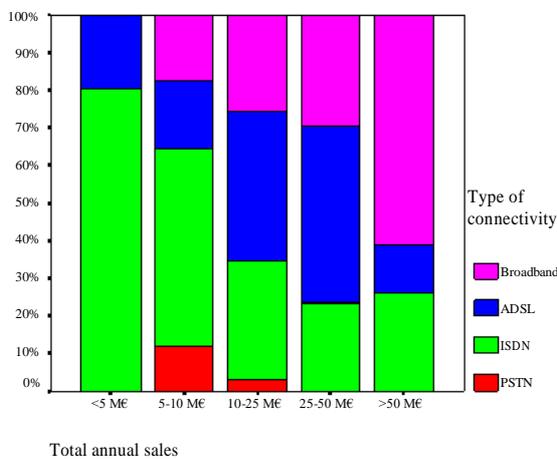


Figure 2: Connectivity vs. Total annual sales (significant at  $p < 0.003$  according to G-K  $\tau$  with “connectivity” dependent)

This bottleneck prevents ASPs from fulfilling one of their promises, i.e., the filling of the technology divide separating the larger companies from the smaller ones.

## 2.2. Diffusion of ICT in the Workplace

The diffusion of personal computers in firms is quite high. On average, firms have one PC for every 4.12 employees [Fig.3]. By adding terminals the figure becomes one workstation for every 3.07 employees.

This means that almost every employee is in some way “reached” or “reachable” by the IT applications. This figure is independent from the size of firms.

Moreover, almost all PCs (about 90% on average) are connected to the Internet. This implies that they easily be used as clients for centrally managed applications, as required by the ASP model.

## 2.3. Hardware and Software Architecture

We have observed that the client/server architecture is by and large the one with greater diffusion, either used alone or together with other solutions. There is also a certain utilization of Intranet architectures, in which clients are simple browsers. This experience with “thin clients” may facilitate the adoption of the ASP model [Fig.4].

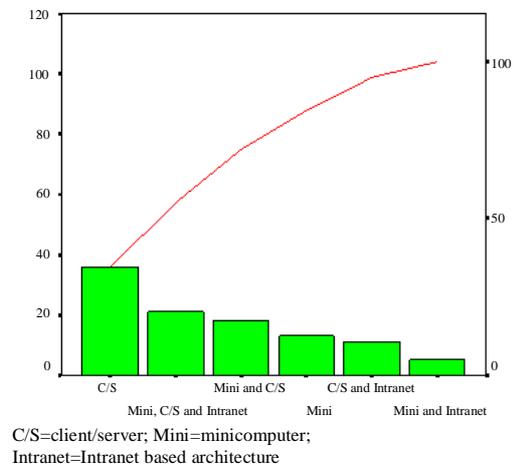


Figure 4: Hardware architecture

As expected, there is a strong relationship between the type of hardware architecture and firm size. Intranet-based architectures can be only found in firms with total annual sales higher than 50 million €. Smaller firms’ lack of experience could be another disadvantage for adopting and exploiting the ASP model [Fig.5].

From the point of view of business applications, almost 50% of firms have just adopted systems with native integration (i.e., ERP), while only 13.6% have non-integrated applications. The remaining firms had to integrate applications with custom software development [Fig.6].

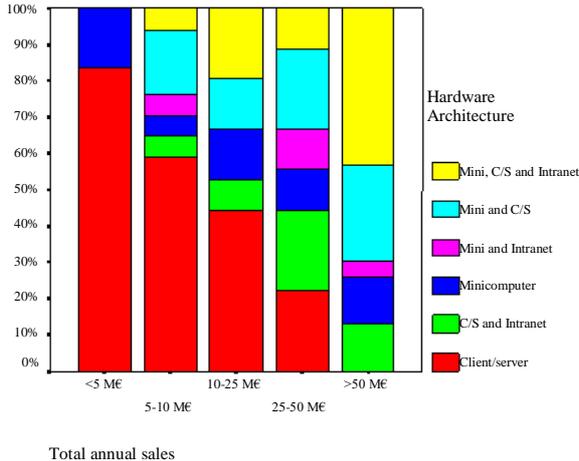


Figure 5: Hardware architecture vs. total annual sales (significant at  $p < 0.001$  according to Lambda statistic with “Hardware Architecture” dependent)

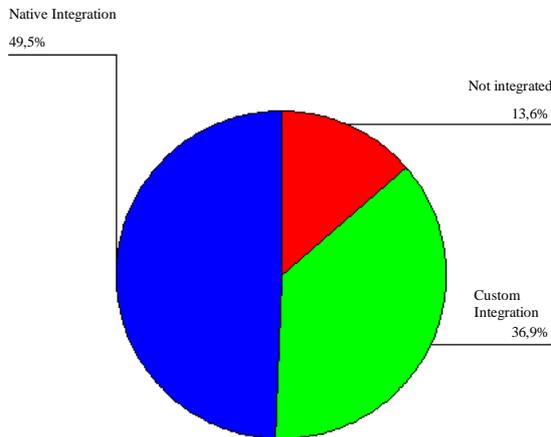


Figure 6: Level of integration of applications

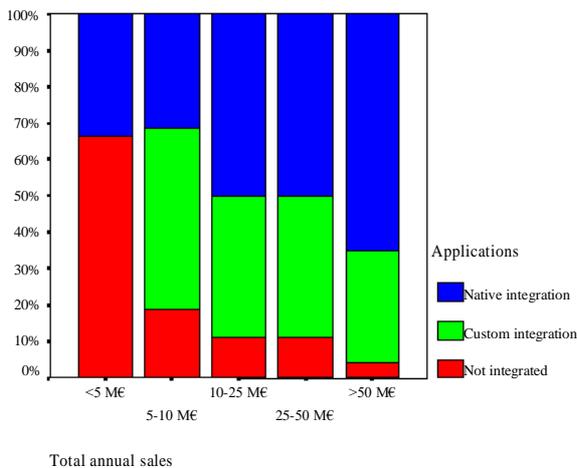


Figure 7: Type of integration vs. total annual sales (significant at  $p < 0.009$  according to Kendall’s  $\tau$ -b with “Applications” dependent)

Native integration is more common in the larger companies, even though it is noteworthy that none of the smallest ones (annual sales less than 5 million €) have attempted “customized integration” [Fig.7].

## 2.4. Available and Future Business Applications

By studying the diffusion of specific business applications in different functional areas, we see that only very few firms nowadays do not have specific applications supporting their activities [Tab.1].

Table 1: Business activity supported by specific applications

Business activity	Percentage of actual adoption
Manufacturing	87.5 %
Administration	100 %
Sales	76.9 %
Human Resources	76 %
Product Design	88.5 %

In order to estimate the diffusion potential of a number of business applications we have also considered the will/use ratio [Tab.2].

Table 2: percentage of diffusion of some applications and will/use ratio

Applications	Present adopters	Future adopters (in 2002)	Will/use
<b>Manufacturing</b>			
MRP	57,7%	8,7%	15,0%
Scheduling systems	26,0%	12,5%	48,1%
Quality control systems	47,1%	10,6%	22,4%
Production activity control	61,5%	10,6%	17,2%
EDI – Electronic Data Interchange	51,0%	5,8%	11,3%
<b>Administration</b>			
Accounting	98,1%	1,0%	1,0%
Workflow and document management	26,9%	10,6%	39,3%
Management of finances	91,3%	2,9%	3,2%
<b>Sales</b>			
e-commerce	5,8%	8,7%	150,0%
Catalogues and pricelist editing	38,5%	3,8%	10,0%
Customer Database management	68,3%	4,8%	7,0%
Newsletter editing	25,0%	5,8%	23,1%
Sales force automation	55,8%	4,8%	8,6%
<b>Human resources management</b>			
Payroll	63,5%	1,0%	1,5%
Travel expenses	34,6%	1,9%	5,6%
Recruiting, evaluation and training of H.R:	38,5%	1,9%	5,0%
publishing of internal procedures on the Intranet	19,2%	4,8%	25,0%
<b>Product development and management</b>			
EDM / PDM	26,0%	8,7%	33,3%
Project management	44,2%	10,6%	23,9%
CAD	79,8%	2,9%	3,6%
CAM	30,8%	3,8%	12,5%
CAE	21,2%	3,8%	18,2%

This is defined as the ratio between the number of firms who plan to adopt an application in the current year (2002) and the number of firms who have already adopted it. This may be considered to be a good indicator of the instantaneous growth rate for the application. Specifically, the ratio discriminates among applications approaching market saturation and the ones that are at the beginning of their diffusion process. This is relevant since the former could only be adopted through ASPs by substitution of existing installations, while the latter may diffuse directly through the ASP model.

Most firms do have a web-site, which is mainly used for offering information to customers and suppliers. Very few firms are however able to carry out transactions online [Fig.8].

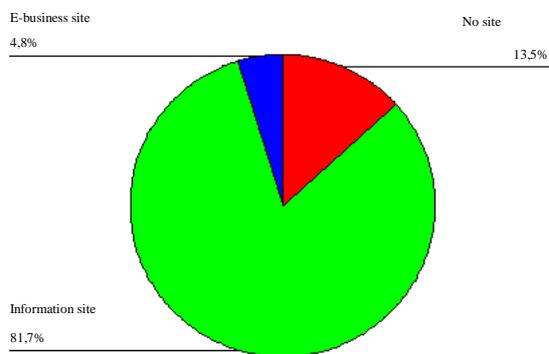


Figure 8: Web-site content

By considering the location in which the web-site is hosted, we notice that the dominant solution is through a service provider. Only 19.4% of firms have their web-site hosted on their own servers.

This type of outsourcing is generalized for the smaller firms, but is also very common among the bigger ones [Fig.9].

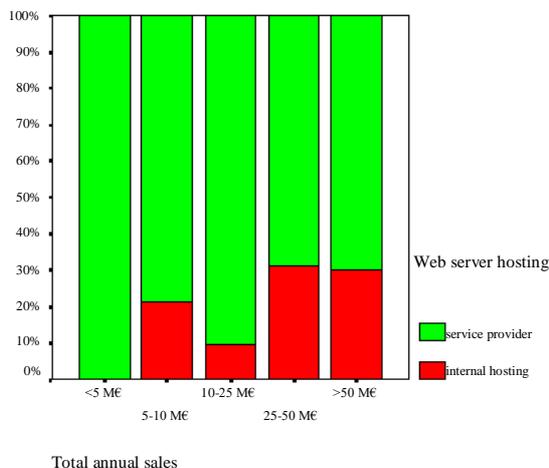


Figure 9: Web server hosting vs. total annual sales (significant at  $p < 0.072$  according to Kendall's  $\tau$ -b with "Web server" dependent)

This may be seen as the result of a high level of confidence with outsourcing. However, it may also be due to the fact that since the website is not able to perform transactions, it is not considered to be a mission critical application.

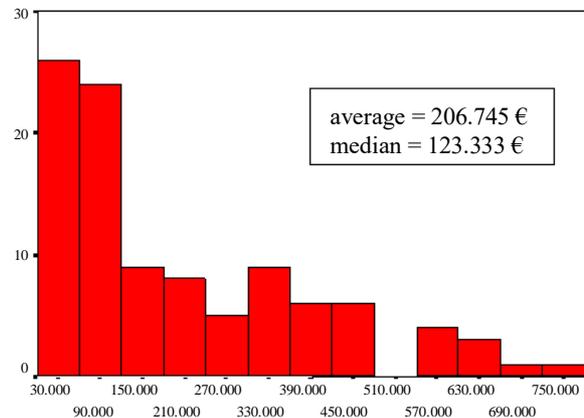
### 3. ICT Cost and Strategy

Another section of the questionnaire was aimed at understanding the cost of ICT and the assessment of the value it creates. The most relevant statistics follow.

#### 3.1. ICT Total Cost of Ownership

The cost of ICT has been calculated by adding up annual costs for hardware, software, connectivity, human resources assigned to ICT, assistance and maintenance, consultancy and training.

This total annual cost is averagely 207,000 €, but the statistical distribution is strongly skewed by few high spending firms; in fact, the median value is much more lower and is equal to 123,000 € [Fig.10].



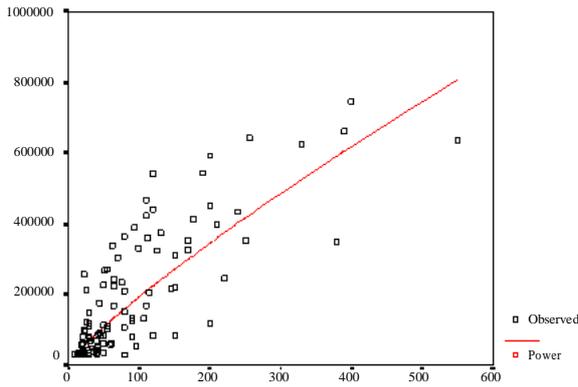
ICT annual total cost and dedicated personnel

Figure 10: Distribution of total annual expense for ICT

We have found that economies of scale in ICT are present. We have considered the number of PCs as an indicator of the size of firms' ICT functions and used the following Cobb-Douglas model:

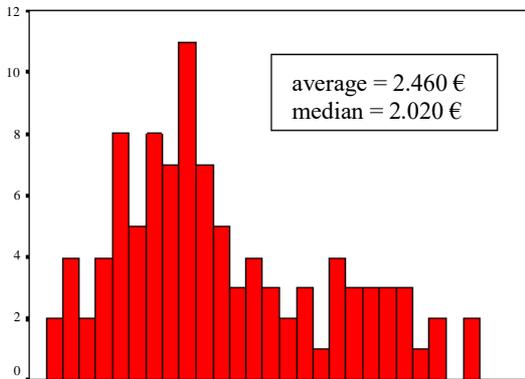
$$y = b_0 x^{b_1} \quad (1)$$

where "y" is the total annual expenditure in ICT and "x" is the number of PCs and terminals. Minimum square estimation of a linearized version of (1) has given a parameter  $b_1 = 0.8384$  (a value less than 1 indicates the existence of economies of scale) with a good level of correlation ( $R^2 = 0.618$ ). To easily understand the entity of this value, this implies that every time the number of work places managed doubles, one can have 11% of savings.[Fig.11]



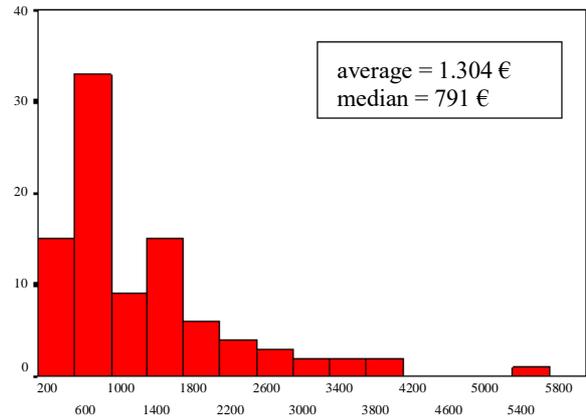
PCs and terminals  
 Figure 11: Annual ICT expenditure vs. number of work places

One of the most interesting findings of the research is associated to the analysis of ICT cost of ownership. This cost is very low, if divided by the firms' number of workstations [Fig.12] or by the number of employees [Fig.13] Thus measured, the cost of ICT is one order of magnitude less than the cost of the personnel using these technologies. In first approximation, it is evident that investments in ICT may return profits even for small improvements of productivity.



ICT annual expenditure per single work station  
 Figure 12: Distribution of the ICT cost for single workstation

Moreover, the relatively low cost of ICT may suggest that this may not represent a critical factor in determining firms' investment decisions. In fact, only 28% of CEOs recognize financial shortage as an obstacle to investing in hardware or software. Moreover, 62% of firms have stated that if savings in ICT were possible, the money would be spent in the same activity area. Another 15% of CEOs define the ICT budget to be "not so significant" if compared to the total amount of investments.



ICT annual expenditure per total firm's employees  
 Figure 13: Distribution of the ICT cost for single employee

### 3.2. Perceived Value of ICT

Firms are usually pleased with the level of the service that their ICT equipment gives to operational activities [Fig.14]. This assessment is not correlated with the firms characteristics (i.e. size), but is correlated with the architecture adopted. Dissatisfaction is located in firms that have implemented the simpler hardware architectures ("pure" Client/Server or minicomputer) or which have not integrated their business applications [Fig.15 and Fig.16].

This does not explain whether the dissatisfaction is due to the architectural choice or to the fact that applications based on these architectures may be less up-to-date.

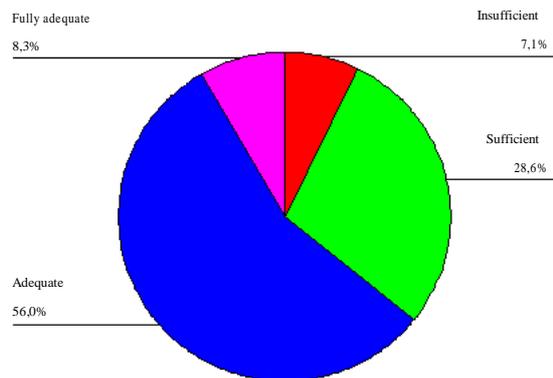


Figure 14: Level of service offered to the firm's operations

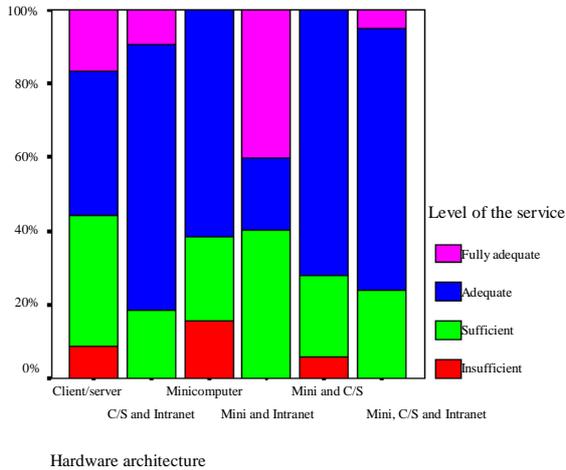


Figure 15: Level of the service offered to the operation vs. hardware architecture (significant at  $p < 0.060$  according to G-K  $\tau$  with “Level of Service” dependent)

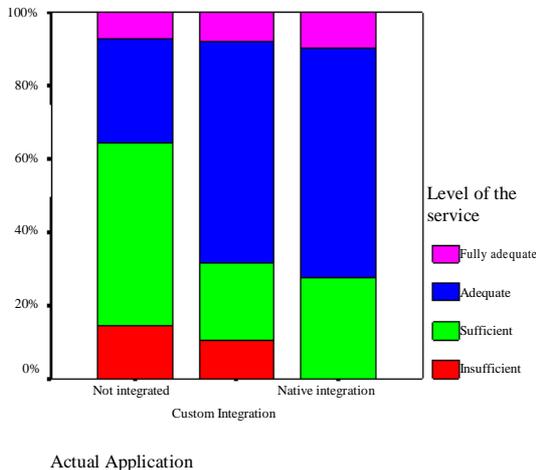


Figure 16: Level of the service offered to the operation vs. level of integration (significant at  $p < 0.040$  according to G-K  $\tau$  with “Level of Service” dependent)

We have asked both the CEOs and the CIOs to express their opinion about the cost of the ICT and the value it creates. The three options were “the value created by ICT is higher / equal / lower than its cost”. By comparing the answers provided by CEOs and CIOs we have noticed that an interesting correlation exists between the differences in the judgments and the annual expenditure per employees. CEOs are more satisfied than CIOs when expenditure is low and vice versa [Fig.17]. This correlation may suggest that the higher management is more interested in keeping costs under control, rather than in their related returns.

Incidentally, CEOs generally state that it is difficult to evaluate ICT investments properly, especially because of their lack of tangibility [Fig.18]. This difficulty is especially found in the smaller firms [Fig.19]. This may suggest that alternative models for managing ICT, such as Application Service Provisioning, must be accompanied by tools helping firms to evaluate properly the cost of ownership and the ROI of their choices.

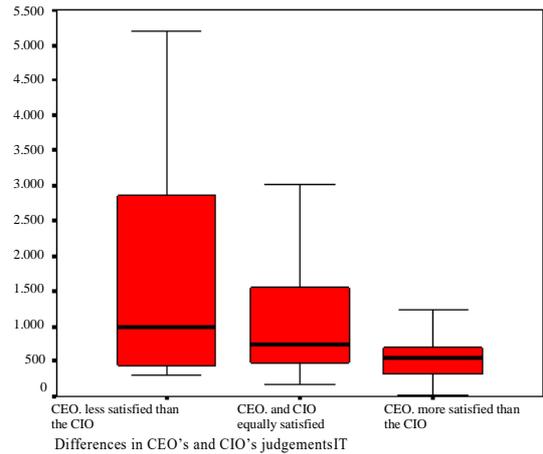


Figure 17: Differences in CEO's and CIO's judgments vs. annual expenditure per employees (significant at  $p < 0.087$  with ANOVA)

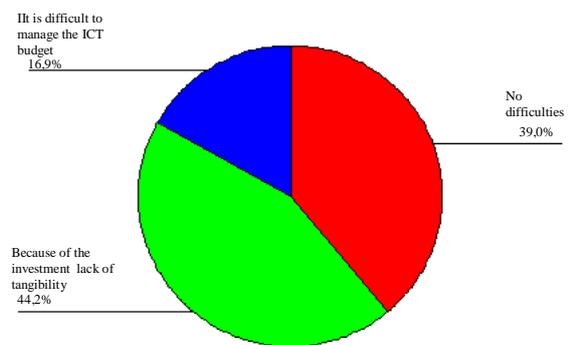


Figure 18: Difficulties in managing the ICT investments

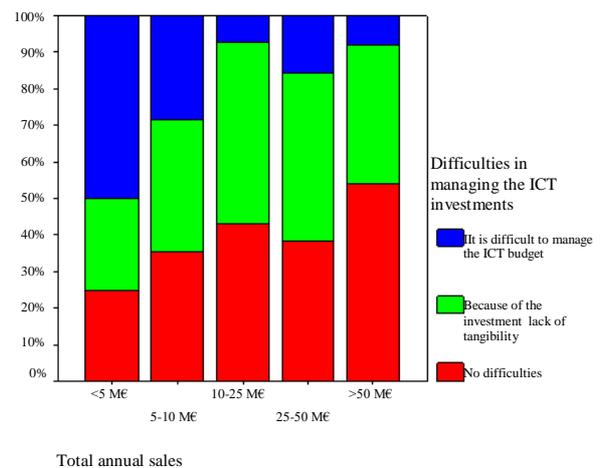


Figure 19: Difficulties in managing the ICT investments vs. total annual sales (not statistically significant)

### 3.3.The Evaluation of the ASP

In order to understand the way in which firms perceive the ASP model, the firms were asked to provide an evaluation of the importance of a number of advantages and disadvantages. The evaluations have been expressed in a Likert scale ranging from 1 to 5.

Firms generally do not give a high evaluation of potential advantages of ASP. The advantage that the firms are most interested in seems to be the external management of hardware and software upgrades [Tab.3]. The disadvantages that firms worry most about are related to losing control on confidential data and the risk of high future switching costs [Tab.4].

Table 3: Evaluation of potential ASP advantages

Potential Advantages	Average evaluation
Focus on core business	2.10
Easier access to new applications	2.73
External management of hardware and software upgrades	2.76
Continuous assistance	2.56
Proposal of new applications	2.04
Evaluation of applications	2.55

Table 4: Evaluation of potential ASP disadvantages

Potential Disadvantages	Evaluation
Loss of control on confidential information	2.96
Switching cost for changing provider	2.86
Loss of control on a strategic area	2.80
Higher total cost	2.68
Worse service level	2.40
Lower reliability of hardware	2.29
Higher vulnerability to viruses	2.44
Higher vulnerability to hackers	1.96

It is important to notice that the concentration of the evaluations between “2” and “3” means that firms are generally slightly sensitive towards both advantages and disadvantages. So, it has been considered appropriate to widen the analysis and to use Principal Component Analysis in order to define the “perceptual space” with which firms evaluate the concept of ASP.

The underlying conceptual model is a “lens model”, as used in marketing research [Fig.20]. In this model, the perception of the ASP solution is influenced by variables related to the firm’s strategic focus and by variables related to past experience with ICT. We then hypothesize that the perception of ASP influences the inclination towards adopting this paradigm and, specifically, of using ASP for new applications rather than for substituting existing ones.

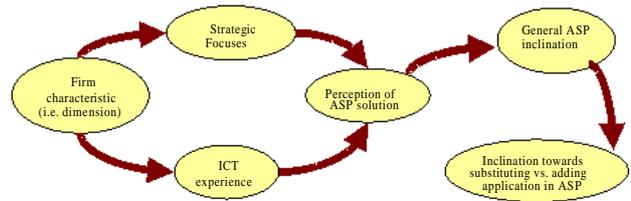


Figure 20: ASP perception (lens model)

Principal Component Analysis has shown the existence of three latent variables, or leading perceptive dimensions, that are able to explain the 61% of variance in firms’ evaluations. The following Tab.5 shows the loading parameters, which express the correlation between original and latent variables, after applying Varimax rotation. The most significant loading parameters are highlighted in grey. Looking at the table we have named “perception of advantages” the first latent variable (given by variables from 1 to 6), “perception of technological disadvantages” the second (given by variables 7 and 12 through 14), “strategic disadvantages perception” the third (given by variables from 8 to 11). To make analysis easier the latent variables have then been transformed into binary values “low” and “high”, so that each value comprises the 50% “lower” and “higher” firms.

Table 5: Factorial analysis on ASP perception

Variable	Latent variable	1	2	3
1. Focus on core business		0,639	0,197	-0,171
2. Easier access to new applications		0,741	0,011	0,026
3. External management of hardware and software upgrades		0,693	0,141	-0,024
4. Continuous assistance		0,715	0,316	-0,055
5. Proposal of new applications		0,733	-0,018	0,253
6. Evaluation of applications		0,763	-0,003	0,141
7. Loss of control on confidential information		0,088	0,681	0,238
8. Switching cost for changing provider		0,172	0,147	0,664
9. Loss of control on a strategic area		0,088	0,404	0,616
10. Higher total cost		-0,087	0,089	0,761
11. Worse service level		-0,047	0,296	0,737
12. Lower reliability of hardware		0,177	0,833	0,233
13. Higher vulnerability to viruses		0,151	0,878	0,148
14. Higher vulnerability to hackers		0,074	0,896	0,213

The three new variables now allow us to locate the firms in the perceptual space and to understand their profile. The main correlations found are the following:

- The perception of advantages is higher in firms that affirm to compete in product innovation and in the firms with direct contact to the market (not producing for firms in the same group).
- The perception of technological disadvantages is

stronger in firms with lower overall investments.

- The perception of strategic disadvantages is stronger in firms with high overall investments and focused upon cost/price competition. There is also a generalized correlation of this perception with the level of the owned ICT (external connection speed, hardware architecture, level of integration of the applications): this fact may suggest that firms with a high profile ICT equipment have reached a stronger awareness about the importance of ICT activities and, moreover, being in a better position, they are more worried about the risks that an externalisation could cause.

### 3.4. The Inclination to ASP

In order to understand the inclination of the firms towards the possibility of adopting some applications in the ASP model, we have asked them to assess their interest using values ranging from 1 (low interest) to 4 (high interest).

Table 5: Interest in ASP supply

Applications	Interest in ASP supply	No / low interest	High Interest
<b>Manufacturing</b>			
MRP	1.79	75.3%	24.7%
Scheduling systems	1.88	72.4%	27.6%
Quality control systems	1.91	75.3%	24.7%
Production activity control	1.86	72.8%	27.2%
EDI – Electronic Data Interchange	2.21	60.0%	40.0%
<b>Administration</b>			
Accounting	1.99	71.3%	28.7%
Workflow and document management	2.05	77.0%	33.0%
Management of finances	1.54	88.0%	12.0%
Office automation	1.91	70.4%	29.6%
E-mail server	1.72	78.5%	21.5%
Business website	2.33	51.7%	48.3%
<b>Sales</b>			
e-commerce	1.94	70.4%	29.6%
Catalogues and pricelist editing	1.83	75.0%	25.0%
Customer Database management	1.82	77.5%	22.5%
Newsletter editing	1.88	70.5%	29.5%
Sales force automation	2.00	67.9%	32.1%
<b>Human resources management</b>			
Payroll	1.77	77.9%	22.1%
Travel expenses	1.83	75.0%	25.0%
Recruiting, evaluation and training of H.R:	1.82	71.4%	28.6%
publishing of internal procedures on the Intranet	1.79	75.8%	24.2%
<b>Product development and management</b>			
EDM / PDM	1.82	80.6%	19.4%
Project management	1.53	87.5%	12.5%
CAD	1.39	91.8%	8.2%
CAM	1.40	93.0%	7.0%
CAE	2.29	56.5%	43.5%

We also have asked to return value 0 for applications they are not interested in at all. The average values are quite low, but it is important to notice they are burdened by a number of very negative evaluations: if we consider only the percentage of firms that have expressed a high level of interest (values 3 or 4) we can find that according to the type of application, this goes from a disappointing 7% to a more promising 43% [Tab.5].

In order to have a concise measure of firms' inclination to ASP we have defined a "high" inclination when the firm has expressed a high interest for a number of applications greater than the number of applications for which it has expressed no or low interest.

We have found that the inclination is linked with the perception of ASP. Specifically, inclination is higher for firms with a high perception of the advantages (as one might easily assume) and in the firms with high perception of technological disadvantages (which shows that these disadvantages are not so important). Moreover there is not a correlation with the strategic disadvantages dimension. This could suggest that this perceptual dimension should not constitute a real hindrance for adoption of ASP.

### 3.5. Approaches to ASP

In most cases, firms declared ASP to be a possible solution for adopting new applications (75.5%) while only 24.5% of them claimed to be interested in the substitution of the present supply model.

This finding significantly bounds the potential of the ASP market for those applications that have approached saturation.

As expected, the type of approach is correlated to the inclination to the ASP model (firms with substitution strategy generally have higher inclination). Moreover, it is correlated to the level of services offered to operations by ICT. Inclination to substitute current applications is higher for firms where service level is not satisfactory (these firms are probably looking for better solutions) and for firms where it is fully adequate (one may hypothesize that firms with greater experience are more interested in innovative solutions) [Fig.21].

### 3.6. Inclination to the Outsourcing of ICT

In our research we asked CEOs to declare their strategy regarding the possibility of outsourcing ICT [Fig.22]. Most CEOs think it is better to keep ICT activities within the firm for the applications considered to be strategic (58.1%) or even for all applications (20.3%). Very few firms are inclined to a total outsourcing (12.3%), or to a choice based only upon financial considerations (9.5%).

Firms that expressed a greater inclination to outsourcing are generally stand-alone firms (not subsidiaries of a group), with total annual sales ranging between 5 and 50 million €, and have adopted the simpler hardware architectures.

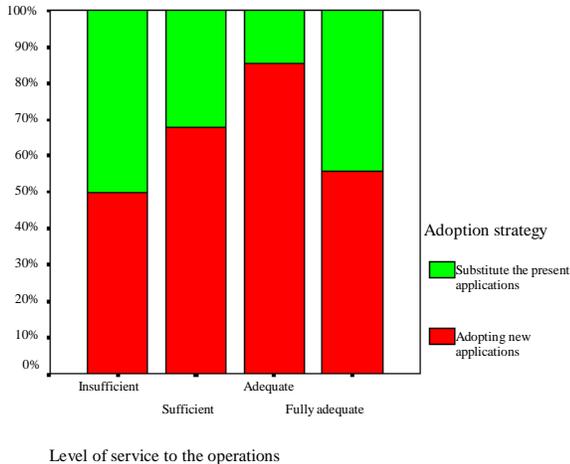


Figure 21: Adoption Strategy vs. level of service to the operations (significant at  $p < 0.05$  according to G-K with “Adoption strategy” dependent)

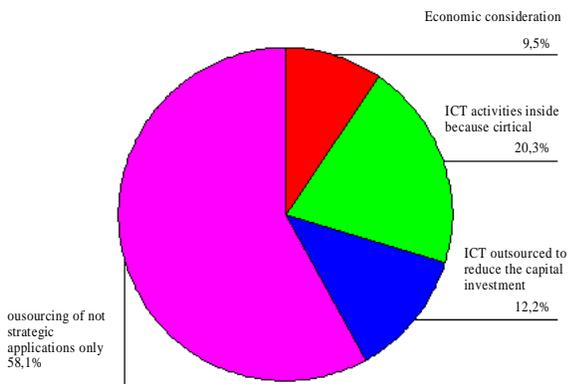


Figure 22: Inclination to ICT outsourcing

#### 4. Concluding Remarks

These summarized findings lead to concluding remarks that can be relevant to the possible evolution of the ASP market:

- The initial ASP value proposition oversimplified IT needs and costs inside firms. Firms probably do not own “state of the art” applications, but what exists is the result of a long “learning by doing” process that makes it difficult to integrate ASPs offer with existing IT infrastructure.
- It is very difficult for ASP to pursue a “low cost” and/or “one-stop shopping” strategy. ASPs will have to offer initially “additional” applications, in order to gain customers’ trust and to build long-term relationships.
- The cost of customer acquisition is high, as is the cost for keeping service levels fixed in SLAs. The

importance of on-site services will probably compel ASPs to establish alliances with systems integration firms that already have a customer oriented structure;

- ASPs will have to invest more in making their customers conscious of the benefits of their services; results shows that there is a strong positive correlation between understanding of benefits and will of use;
- Lacking a killer application, differentiation strategies (focused on a small number of innovative, non-core applications) seem to be the most promising for ASPs. Research results show that - depending on the application - the fraction of firms highly interested in acquiring them through ASPs may range from a disappointing 7% to a promising 48%;
- The “hidden cost” of this choice is the risk to miss the promise of IT overall cost reduction and of applications integration;
- “Pure player” ASPs will suffer from competition from a wide range of competitors, including:
  - specialized suppliers of “traditional” services that will modify their offer according to the ASPs model;
  - systems integrators that already control firms’ IT infrastructure;
  - software vendors, that can easily start selling their products in ASP mode;
  - telecom providers, that will bundle Application Service Provisioning inside their broadband services.

In summary, these issues greatly reduce the expected profitability of the ASP model, which will probably require a long time before becoming acceptable. Questions to be addressed by future research are related to:

- the ASP’s ability to deliver value to SMEs, becoming a key factor for their growth;
- the survival of ASP as an independent market, since vertical integration could force pure players out of the market;
- the emerging structure of the business software value chain and the characteristics of firms that will control it.

#### References

- [1] Gartner Group, ASPs: What Went Wrong?, November 2001
- [2] Gartner Group, Application Service Providers:U.S. Marketplace Demographics,2001 October 2001
- [3] Gartner Group, Enterprise Application Outsourcing: The Truth Is in Here, December 2001
- [4] Gartner Group, ASPs in 2002:Prediction, January 2202

# ENAT-PT: An Enhanced NAT-PT Model

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## Abstract

NAT-PT would allow IPv4 nodes to communicate with IPv6 nodes transparently by translating the IPv6 address into a registered V4 address. However, NAT-PT would fall flat when the pool of V4 addresses is exhausted. NAPT-PT multiplexes the registered address' ports and will allow for a maximum of 63K outbound TCP and 63K UDP sessions per IPv4 address, but it is unidirectional. We present in this paper a novel solution ENAT-PT (an enhanced NAT-PT) , which will allow for a great number of inbound sessions by using a single V4 address. By using ENAT-PT, we can visit V6 networks from a V4 network with a small address pool.

Key words: ENAT-PT; IPv6 Transition; NAT-PT; NAPT

## 1. Introduction

The key to a successful IPv6 transition is compatibility with the large installed base of IPv4 hosts and routers. Maintaining compatibility with IPv4 while deploying IPv6 will streamline the task of transitioning the Internet to IPv6. IPv6 transition mechanisms include providing complete implementations of both versions of the Internet Protocol[1,2], and tunneling IPv6 packets over IPv4 routing infrastructures[3,4]. They are designed to allow IPv6 nodes to maintain complete compatibility with IPv4, which should greatly simplify the deployment of IPv6 in the Internet, and facilitate the eventual transition of the entire Internet to IPv6. Another important and widely used technology is NAT-PT[5-9]. Network Address Translation is a method by which IP addresses are mapped from one address realm to another, providing transparent routing to end hosts. Protocol Translation define the translation rules between IPv4 headers and IPv6 headers[10]. Traditional NAT-PT such as NAPT-PT is unidirectional while Bi-Directional-NAT-PT allows IPv4-only node to visit IPv6-only node and vice versa, but Bi-Directional-NAT-PT can not reuse a registered address for more than one session. Thus, we develop ENAT-PT to solve this problem. The most outstanding feature of ENAT-PT is that ENAT-PT is bi-directional and it requires only a small pool of registered addresses.

The rest of this paper is organized as follows. Section 2 defines the frequently used terms in this paper. Section 3 introduces background knowledge such as NAT-PT and its variations; besides, we give the

reason why ENAT-PT is proposed. Section 4 presents the principle of ENAT-PT model and describes its operation in detail. Section 5 analyzes the constraints of ENAT-PT model and discusses other considerations related to ENAT-PT. Section 6 concludes the paper.

## 2. Terms

Terms frequently used in this paper are defined as below. They may have special meaning in this paper.

Definition 1. V4 node, V6 node: In this paper, we use the term V4 node to denote V4-only node, and V6 node to denote V6-only node[1].

Definition 2. Session: A session is defined as the set of traffic that is managed as a unit for translation [11]. Sessions are uniquely identified by their session parameters. For TCP/UDP sessions, session parameters are the tuple of (Sa, Sp, Da, Dp); for ICMP query sessions, session parameters are the tuple of (Sa, ICMP query ID, Da). Sa, Sp, Da, Dp stand for source address, source port, destination address, destination port respectively.

Definition 3. Inbound session and outbound session : A session flow indicates its direction in which the session is initiated with reference to a network interface [11]. In this paper, an inbound session flow is defined as a session flow initiated from a V4 node (to a V6 node), while an outbound session flow is initiated from a V6 node (to a V4 node).

Definition 4. NAT (Network Address Translation): In this paper, NAT refers to translation of an IPv4 address into an IPv6 address and vice versa. While the V4 NAT [6,11] provides routing between private V4 and external V4 address realms, NAT in this paper provides routing between a V6 address realm and an external V4 address realm.

## 3. NAT-PT and Its Flavors

NAT-PT (Network Address Translation - Protocol Translation) is a standard track IETF RFC describing an IPv6/IPv4 translator. NAT-PT allows native IPv6 hosts and applications to communicate with native IPv4 hosts and applications, and vice versa. An NAT-PT device resides at the boundary between an IPv6 and IPv4 network. Each NAT-PT device retains a pool of globally routable IPv4 addresses which are used to assign to IPv6 nodes on a dynamic basis as sessions are initiated across the IPv6/IPv4 boundary. In addition to address translation, header translation is performed as described in the SIIT mechanism[10]. As opposed to SIIT which is a stateless translation mechanism,

NAT-PT retains state via the IPv4 to IPv6 address mappings and which are retained for the duration of each session.

### 3.1 Traditional-NAT-PT (Outbound NAT-PT)

Traditional-NAT-PT would allow hosts within a V6 network to access hosts in the V4 network. In a traditional-NAT-PT, sessions are unidirectional, outbound from the V6 network. This is in contrast with Bi-directional NAT-PT, which permits sessions in both inbound and outbound directions. There are two variations to traditional-NAT-PT, namely Basic-NAT-PT and NAPT-PT.

#### 3.1.1 Basic-NAT-PT

With Basic-NAT-PT, a block of V4 addresses are set aside for translating addresses of V6 hosts as they originate sessions to the V4 hosts in external domain. For packets outbound from the V6 domain, the source IP address and related fields such as IP, TCP, UDP and ICMP header checksums are translated. For returned traffic, the destination IP address and the checksums as listed above are translated.

#### 3.1.2 NAPT-PT

NAPT-PT extends the notion of translation one step further by also translating transport identifier (e.g., TCP and UDP port numbers, ICMP query identifiers). This allows the transport identifiers of a number of V6 hosts to be multiplexed into the transport identifiers of a single assigned V4 address. NAPT-PT allows a set of V6 hosts to share a single V4 address. NAPT-PT can be combined with Basic-NAT-PT so that a pool of external addresses are used in conjunction with port translation. NAPT-PT allows for a maximum of 63K outbound TCP and 63K UDP sessions per V4 address. For packets outbound from the V6 network, NAPT-PT would translate the source IP address, source transport identifier and related fields such as IP, TCP, UDP and ICMP header checksums. Transport identifier can be one of TCP/UDP port or ICMP query ID. For returned traffic, the destination IP address, destination transport identifier and the IP and transport header checksums are translated.

#### 3.1.3 ALG

The NAT-PT translation device may additionally contain ALG's (Application Level Gateways). ALG's are necessary where IP addresses are embedded within the payload of an IP packet. For normal packet translation, NAT-PT would not look within the payload for IP addresses. For some applications where IP addresses may be embedded within the payload, an ALG is necessary to look inside the payload and translate those IP addresses.

### 3.2 Bi-Directional-NAT-PT

With Bi-directional-NAT-PT, sessions can be initiated from hosts in V4 network as well as the V6 network. V6 network addresses are bound to V4 addresses, statically or dynamically as connections are

established in either direction. The name space (i.e., their Fully Qualified Domain Names) between hosts in V4 and V6 networks is assumed to be end-to-end unique. Hosts in V4 realm access V6-realm hosts by using DNS for address resolution.

A DNS-ALG[12,13] must be employed in conjunction with Bi-Directional-NAT-PT to facilitate name to address mapping. Specifically, the DNS-ALG must be capable of translating V6 addresses in DNS queries and responses into their V4-address bindings, and vice versa, as DNS packets traverse between V6 and V4 realms.

### 3.3 Challenge

NAPT-PT allows a set of V6 hosts to share a single V4 address, but NAPT-PT is unidirectional and applicable only for outbound sessions. With Bi-directional-NAT-PT model, however, every registered address is bound to a single V6 address. Once the address pool is exhausted, V4 nodes cannot establish sessions with other V6 nodes anymore. Thus there brings a challenge: how to establish a great number of inbound sessions by using a single V4 address ? ENAT-PT, which stands for Enhanced NAT-PT, will provide a better solution.

## 4. ENAT-PT

### 4.1 ENAT-PT Overview

ENAT-PT comprises of three parts: ENAT, NAPT and PT, see table 1.

The following of this paper mainly focuses on ENAT. For more information about NAPT and PT, please refer to references [5-11].

Table 1 ENAT-PT model components

Session Direction	Address Translation Method	Header Translation Method
Outbound	NAPT	PT
Inbound	ENAT	PT

With Bi-directional-NAT-PT, every registered address is bound to a single V6 address when a DNS query is performed and released when the session is terminated. With ENAT, a registered address bound to a V6 address would be released at the open of a session instead of the session's termination. Thus a registered address may be reused for another session just after the establishment of a session. Destination address (or source address of returned traffic) of subsequent packets of a session would be translated to the correct translated address according to their session parameters, which are retained in a session table.

### 4.2 ENAT Operation

Like NAT-PT, an ENAT-PT device resides at the boundary between an IPv6 and IPv4 network. Each ENAT-PT device retains a pool of globally routable IPv4 addresses (or registered addresses) which are used to assign to IPv6 nodes on a dynamic basis as sessions

are initiated across the IPv6/IPv4 boundary. Besides, the ENAT-PT should maintain two tables, namely session table and binding table. The session table is as follows.

V4 Address	V4 Port	V6 Address	V6 Port	Translation Address
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V4(V6) port here denotes the port associated to the V4(V6) address. There is an entry in the session table for each session.

The binding table is as follows.

Registered Address	Binding Address	State
--------------------	-----------------	-------

There is an entry for each registered address in the binding table. The state of a registered address may be free, bound, occupied, or occupied and bound. See definition 5 below.

Definition 5. The state of a registered address:

Free: the initial state.

Bound: when the ENAT-PT bind it to a V6 host.

Occupied: when a registered address is used by some session, i.e., it's in the session table.

Occupied and bound: Occupied by one or more sessions, and, at the same time, bound to a V6 address.

The ENAT operation is as follows:

1. A DNS query should be performed before a session is established. This is done by the facilitation of the DNS-ALG, which is naturally embedded in an ENAT-PT. The DNS-ALG translates the DNS query and the ENAT-PT forwards it to the DNS server. The ENAT-PT will choose a registered address whose state is not bound (or occupied and bound) and bind it to the V6 address returned by the DNS server. The address binding will be added to the binding table. ENAT-PT returns the registered address as the translation address

of the destination V6 node. This is very similar to the binding procedure in NAT-PT. If the state of the registered address is free, it should be changed to bound; if it's occupied, it should be changed to Occupied and bound after the binding.

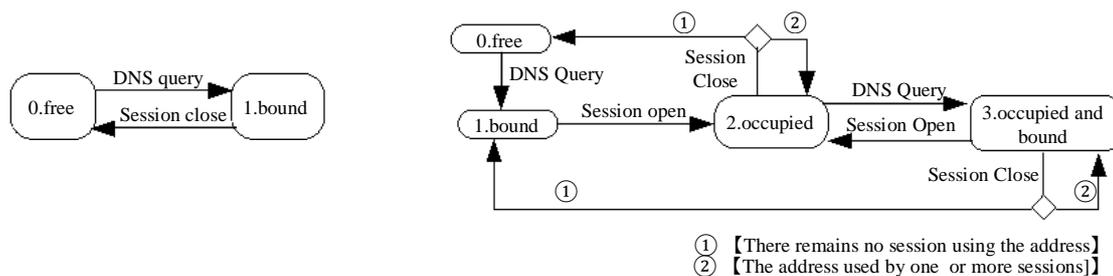
2. The ENAT-PT captures and intercepts the first packet of the session. Destination address of the packet is translated to the V6 address by querying the binding table. An entry, which contains the IP of V4 node, port associated to the V4 address, IP of V6 node, port associated to the V6 address and the translation address, will be added to the session table. Then the state of the registered address is changed to occupied and the address binding will be cleared in the binding table.

3. The ENAT-PT captures and intercepts subsequent packets of the session and translates their addresses by querying the session table.

Fig.1-(b) is the state diagram of a registered address with ENAT. It shows how does ENAT differ from NAT( see Fig 1-(a) as a contrast). Note that when a session is opened, a registered address is released and can be bound to another V6 address.

Fig.2 is an example to illustrate the operation of ENAT. Q1 and Q2 are V4 nodes while H1 and H2 are V6 nodes. There are two registered addresses in the binding table. The registered address R0 is statically bound to the DNS server. The initial state of R1 is free, see table 2. The ENAT-PT will intercept, capture and translate the packets. The session table is empty.

For convenience, we use Q1.address to denote the IP address of Q1, and R1.state to denote the state of Registered address R1...etc.



(a) The state of a registered address with NAT

(b) The state of a registered address with ENAT

Fig.1 The state of a registered address

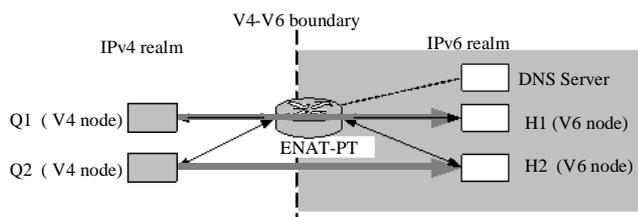


Fig.2 An illustration for ENAT

Table 2 Binding table (0)

Registered address	Bound Address	State
R0	DNS-Server.address	Bound
R1	-	Free

Assume that V4 node Q1 initiates a session to V6 node H1. The DNS server returns R1 as the translation address of H1, thus R1 is bound to H1.address now, the binding table is as follows ( see table 3).

Table 3 Binding table (1)

Registered address	Bound Address	State
R0	DNS-Server.address	Bound
R1	H1.address	Bound

When the session is open, the first packet of the session is delivered from Q1 to H1 whose session parameters are:

$$Sa = Q1.address, Sp = p1, Da = R1, Dp = p2 \quad (1)$$

Then we add the session parameters to the session table (see table 4) and change R1.state to occupied, and the binding table is as table 5.

Table 4 Session table (1)

V4 Address	V4 Port	V6 Address	V6 Port	Translation Address
Q1.address	p1	H1.address	p2	R1

Table 5 Binding table (2)

Registered address	Bound Address	State
R0	DNS-Server.address	Bound
R1	-	Occupied

Address of packets of the session is translated according to the session table. For packets from Q1 to H1, the translation is as follows:

$$(Q1.address, p1, R1, p2) \xrightarrow{\mathcal{A}} (PREFIX::Q1.address, p1, H1.address, p2) \quad (2)$$

for returned traffic, the translation is:

$$(H1.address, p2, PREFIX:Q1.address, p1) \xrightarrow{\mathcal{A}} (R1, p2, Q1.address, p1) \quad (3)$$

NOTE: The prefix PREFIX::/96 is advertised in the stub domain by the ENAT-PT device, and packets addressed to this PREFIX in the stub domain will be routed to the ENAT-PT device. The pre-configured PREFIX only needs to be routable within the IPv6 stub domain and as such it can be any routable prefix that the network administrator chooses [8].

Table 6 Binding table (3)

Registered address	Bound Address	State
R0	DNS-Server.address	Bound
R1	H2.address	Occupied and Bound

Once a registered address is released (when the session the registered address associated to is opened), it can be bound to another V6 address. For example, another V4 node Q2 initiates a DNS query (e.g., resolving the name of node H2) just after the establishment of the previous session. ENAT-PT will bind R1 to H2.address as translation address of H2, see

Table 6.

So session parameters of packets from Q2 to H2 may be:

$$Sa = Q2.address, Sp = p3, Da = R1, Dp = p4. \quad (4)$$

After the session is opened, the session table is as table 7 and the binding table is as table 5.

Table 7 Session table (2)

V4 Address	V4 Port	V6 Address	V6 Port	Translation Address
Q1.address	p1	H1.address	p2	R1
Q2.address	p3	H2.address	p4	R1

For packets from Q2 to H2, the translation is as follows:

$$(Q2.address, p3, R1, p4) \xrightarrow{\mathcal{A}} (PREFIX::Q2.address, p3, H2.address, p4) \quad (5)$$

for returned traffic, the translation is:

$$(H2.address, p4, PREFIX:Q2.address, p3) \xrightarrow{\mathcal{A}} (R1, p4, Q2.address, p3) \quad (6)$$

The above deals with TCP/UDP sessions. For ICMP sessions, the operation is pretty much the same thing, but sessions are identified by their source/destination address and ICMP query ID.

#### 4.3 ENAT Analysis

(1) When the state of a registered address is bound, it can not be bound to another V6 address. The number of sessions that can be set up at the same time by using a single registered address is depended on two factors:  $T_D$ , which is the average duration of a registered address from bound (or occupied and bound) state to occupied state, and  $T_S$ , the average duration of a session.

$$N_{max} = (T_S + T_D) / T_D \quad (7)$$

(2) In table 7, if Q1.address = Q2.address (i.e., Q1 = Q2) and p1 = p3 and p2 = p4, session parameters of the two sessions will be identical (see formula (1) and (4)). The ENAT-PT needs more information to tell one session from the other. In this case, the ENAT-PT should reject the connect request of the second session to avoid confusion. For TCP sessions, the ENAT-PT may discard the SYN & ~ACK packet, however, there is no deterministic way of recognizing the start of a non-TCP session. Fortunately, most operating systems will select different source ports (for the client) for different sessions.

(3) ENAT and NATP are both essential parts of ENAT-PT model. ENAT deals with inbound sessions and NATP deals with outbound sessions. If we use the different registered address pools for inbound and outbound sessions, ENAT and NATP need no modification. However, ENAT and NATP can share the same registered addresses pool and the same session table, but the session table should be changed to the following form because NATP will change the clients' ports.

V4 Address	V4 Port	V6 Address	V6 Port	Translation Address	Translation port
---------------	------------	---------------	------------	------------------------	---------------------

## 5. Related Considerations

### 5.1 The start and Termination of Sessions [11]

The first packet of every TCP session may be recognized by the presence of SYN bit and absence of ACK bit in the TCP flags. There is no deterministic way of recognizing the start of a non-TCP session. A heuristic approach would be to assume the first packet with hitherto non-existent session parameters as indicating the start of a new session. The end of a TCP session is detected when FIN is acknowledged by both halves of the session or when either half receives a segment with the RST bit in TCP flags field. However, because packets may be dropped or retransmitted, TCP sessions can be assumed to have been terminated only after a period of time subsequent to this detection. In addition, it is necessary for an ENAT-PT to clean up unused state about TCP sessions that no longer exist. In the case of non-TCP sessions, session timeouts must be configurable because they vary greatly from application to application. Another way to handle session terminations is to timestamp entries and retire the longest idle session when it becomes necessary.

### 5.2 Limitations[8,11]

Here are the most important limitations with ENAT-PT. They are associated with NAT-PT as well.

(1) Applications depending on global address may work improperly because a registered address may be bound to different V6 addresses at the different time or even at the same time, and vice versa.

(2) An ENAT-PT will not translate IP-address within packet payload thus applications such as SNMP, FTP will not work properly. An SNMP-ALG [14] or an FTP-ALG [15] is necessary for these applications.

(3) A DNS query must be performed before every session opens[8].

### 5.3 Security

Transport layer security techniques such as TLS [16], TCP MD5 Signature Option [17] can work properly because ENAT does not change port numbers. Security mechanisms of IP layer such as AH [18] protect the packet from address modifications and will not work.

### 5.4 Fragmentation

Although ENAT-PT does not translate transport identifiers, it has to know the port in a packet before translating the address and transmitting the packet, thus it is necessary to track record of IP fragments[19].

## 6. Conclusion

We have implemented a prototype of ENAT-PT on Linux based on BT Labs' NAT-PT implementation [20] and succeeded to initiate multi sessions from V4 nodes to different V6 nodes with a single V4 registered

address. ENAT combined with NAT-PT will provide a simple and effective solution for intercommunications between V4 nodes and V6 nodes with a small address pool. This will greatly reduce the consumption of IPv4 registered addresses for IPv4 networks to communicate with IPv6 network.

## Reference

- [1] R. Gilligan, E. Nordmark, "Transition Mechanisms for IPv6 Hosts and Routers", RFC2893, August 2000.
- [2] K. Tsuchiya, H. Higuchi, "Y. Atarashi, Dual Stack Hosts using the Bump-In-the-Stack Technique (BIS)", RFC2767, February 2000.
- [3] P. Fasano, I. Guardini, D. Lento, "IPv6 Tunnel Broker A. Durand", RFC3053, January 2001.
- [4] D. Haskin, "Routing Aspects of IPv6 Transition", Callon, RFC2185, September 1997.
- [5] D. Senie, "Network Address Translator (NAT)-Friendly Application Design Guidelines", RFC3235, January 2002.
- [6] P. Srisuresh, K. Egevang, "Traditional IP Network Address Translator (Traditional NAT)", RFC3022, January 2001.
- [7] T. Hain, "Architectural Implications of NAT", RFC2993, November 2000.
- [8] G. Tsirtsis, P. Srisuresh, "Network Address Translation - Protocol Translation (NAT-PT)", RFC2766, February 2000.
- [9] R. Bush, "Delegation of IP6.ARPA (Updates RFC2874, RFC2772, RFC2766, RFC2553, RFC1886)", RFC3152, August 2001
- [10] E. Nordmark, "Stateless IP/ICMP Translation Algorithm (SIIT)", RFC2765, February 2000.
- [11] Srisuresh, P. and M. Holdrege, "IP Network Address Translator (NAT) Terminology and Considerations", RFC 2663, August 1999.
- [12] G. Tsirtsis, P. Akkiraju, A. Heffernan, "DNS extensions to Network Address Translators (DNS\_ALG)", RFC2694, September 1999.
- [13] Thomson, S., and C. Huitema. "DNS Extensions to support IP version 6", RFC 1886, December 1995.
- [14] D. Raz, J. Schoenwaelder, B. Sugla, "An SNMP Application Level Gateway for Payload Address Translation", RFC2692, October 2000.
- [15] Allman, M., Ostermann, S. and C. Metz, "FTP Extensions for IPv6 and NATs", RFC 2428, September 1998.
- [16] T. Dierks, C. Allen, "The TLS Protocol Version 1.0", RFC2246 January 1999.
- [17] Heffernan, A., "Protection of BGP Sessions via the TCP MD5 Signature Option", RFC 2385, August 1998.
- [18] Kent, S. and R. Atkinson, "IP Authentication Header", RFC 2402, November 1998.
- [19] Postel, J. (ed.), "Internet Protocol-DARPA Internet Program Protocol Specification", RFC 791, September 1981.
- [20] Linux-based Userspace NAT-PT available at <http://www.ipv6.or.kr/english/download.htm>

# A Virtual Prototyping Application (Let Customers Reveal Their “True” Preference)

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## Abstract

In a brief and creative online survey, customers identify new product opportunities. This leads to an integrated market structure/market segmentation analysis. A clickstream-based analytical CRM case study is presented.

## 1. Introduction

We developed an interactive product configuration tool that allows customers to configure their preferred products based on a finite set of product attributes/features. From the perspective of statistical modeling, our application is similar to the conjoint technique. Conjoint is a research tool that marketers frequently use to determine what features a product should have. However, our virtual prototyping (VP) application eliminates the tedious ranking or pair-comparing tasks on numerous pre-specified product configurations. Customers only need to rank their preferred products after they configure these products. Building their preferred products also enables customers to simultaneously consider all product attributes/features, therefore allowing us to measure product attributes/features interaction.

## 2. Research Applications

Our parallel test on a digital camera survey shows that although both conjoint and VP rank product attributes similarly, cross classification on four preferred product profiles yields only a 50% classification rate (hit ratio). On the attribute ranking, functional features (resolution, storage, image capacity) are the most important attributes, followed by brand (Sony, Kodak, Canon, Olympus, Nikon), and physical attributes (body type and lens) are the least important ones. On the cross classification, each respondent configures and ranks four preferred products, and conjoint attribute utilities are applied to these profiles. If two approaches produce a similar result, we would expect a nearly perfect classification. However, we only observe a 50% classification rate. Another survey on a different category also shows a similar finding. We will show a live demo of both approaches and let audiences

judge which approach more reliably captures the true preferences.

Potential use of our application includes new product forecasting and integrated market structure/market segmentation analysis. Because we let respondents freely configure their preferred products based on all product attributes, it enables us to estimate any new product share potential. New product share is further adjusted to reflect the difference in distribution, pricing, and awareness – nonlinear forms are adopted to make the share adjustment. For example, the new Kodak flash card reaches a 30% share of Kodak professional digital camera, and most of the share gain is incremental (mainly drawing from Canon brand).

The above product-focused market structure reveals brands in competition, while customer-focused market segmentation identifies individuals with similar preferences. Latent class segmentation approach is adopted, and preference towards different attributes is assumed to follow a Dirichlet distribution where Dirichlet distribution parameters are estimated using EM algorithm (see appendix). Profiling the Dirichlet segments based on configured products reveals a mix of brand and type segments - Kodak and Canon forms one of the brand-primary segments. Posterior probability analysis enables us to profile segment beyond products. For examples, one can perform media scheduling based on demographics and media usage, and one can also perform advertising copy development based on psychographics and benefit attributes.

## 3. An Analytical CRM Case Study

Our presentation is concluded with an analytical CRM case study that shows how our VP application, in conjunction with clickstream data, is used to develop an online relationship with e-customers.

A global e-commerce jewelry manufacturer offers a variety of jewelry items to those Web shoppers who register at the participating jewelry stores through an in-store kiosk (A more limited choice of jewelry items is offered to non-registrants). Since the company

guarantees a two-day delivery to their registered customers, unfulfilled orders frequently lead to orders cancellation. To be able to anticipate customers' needs and preferences, we invite their core customers to take VP survey on a regular basis. Core customers are identified based on their online surfing patterns. A separate study based on customers' clickstream data classifies customers into one of the four segments (entertainment/fun, information seeker, technology savvy, and surfer – see the table below). The entertainment/fun

segment accounts for about 25% of total customers, but generates over 60% of company revenues. This segment is also more receptive to VP survey than the other three segments. An entertaining and fun Website (jewelry auction, game-like promotion, sweepstakes, design your own jewelry, etc.) is thus customized for their core customers. Website is further personalized based on customers' preference captured during the VP jewelry-designing phase.



#### 4. Future Development

Telecom and financial services are two areas that we believe can benefit greatly from the user-design application. Significant R&D efforts are currently underway to develop VP application in the service industry.

#### 5. Appendix

$P_{ns}^i$  – probability of observation  $n$  belongs to segment  $s$  in iteration  $i$   
 $\Pi_s$  – segment  $s$  size  
 $\theta_s$  – distribution parameter estimates in segment  $s$   
 $f(y_n|\Phi) = \sum_s \Pi_s f_s(y_n|\theta_s)$  where  $\Phi=(\Pi_s, \theta_s)$ ,  $\theta_s=(B_s)$  or  $\theta_s=(B_s, \lambda_s)$   
 $B_s$  - explanatory variables parameter estimates in segment  $s$

the expectation of dependent variable ( $\mu_s$ ) is modeled as a link function of explanatory variables ( $X_p$ ),  
 $g(\mu_s)=\sum_p X_p B_{sp}$   
 $\lambda_s$  – dispersion parameter that characterizes the variance of observations in  $s$

1. At the first iteration  $i=1$ , fix the number of segment  $s$  and generate starting probability  $P_{ns}^1$  randomly.
2. Given  $P_{ns}^i$ , estimate  $\Pi_s$  by using  $\Pi_s = \sum_n P_{ns}^i / N$  and estimate  $\theta_s$  by using either closed-form expressions (e.g., mean and standard deviation of normal distribution) or a numerical optimization procedure.
3. Stop if the change in the log-likelihood between iteration  $i-1$  and  $i$  is sufficiently small where  $Ln L(\Phi) = \sum_n \sum_s [P_{ns} \ln f_s(y_n|\theta_s) + P_{ns} \ln \Pi_s]$
4. Increment iteration from  $i$  to  $i+1$ , and calculate new estimates  $P_{ns}^{i+1}$  by using  $P_{ns} = \Pi_s f_s(y_n|\theta_s) / \sum_s \Pi_s f_s(y_n|\theta_s)$ .
5. Repeat step 2 through 4.

# Impact of Electronic Commerce Customer Relationship Management on Competitive Advantage: A Research Model and Issues

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## Abstract

The paper presents a theoretical discussion of how experts on information systems and the Internet should inform business representatives about the theoretical impact of Internet network use on competitive advantage. Its objective is to propose a model to test the effect of Internet's web tools and trust on the link between customer relationship management (CRM) and competitive advantage. Internet's web tools such as level of informational web site, level of transactional web site and level of security on the web can support the formation and maintenance of customer relationship because they facilitate the way organizations partner, interact and empower. In other words, Internet's web tools can let organizations to build tight trusted relationships with their trading customers who should become loyal to them, rather than to select customers on a transaction by transaction basis from a large pool of non-loyal ones.

## 1. Introduction

Electronic commerce (E-commerce) is maintaining business relationships by means of Internet networks. In fact, E-commerce is a rapidly growing area enjoying considerable attention in conjunction with the emergence of the Internet [29]. Electronic Commerce creates new forms of market, such as electronic matching of sellers and buyers, or enabling a direct exchange between sellers and buyers [1]. The term electronic commerce encompasses many activities carried out through computer networks and the Internet, including interorganizational commerce, intraorganizational transactions, and transactions involving the individual consumer [34].

Many recent studies have predicted that Internet generated revenue will reach more than US\$1000 billion in total by 2003 [14]. Such predictions indicate the importance that is attached to the Internet as a way of supporting business activities. The Internet itself can be regarded as the latest super-diffusion technology [11]; an amalgamation of many networks that has become

available for commercial purposes. Indeed, numerous firms have already experienced its considerable benefits [18]. One of the consequences of the development of the Internet has been the emergence of the World Wide Web, an Internet service that organizes information according to hypermedia and hyperlink paradigms [34]. The Internet's Web is the prime driver of contemporary E-commerce [35]. Given the rapid penetration of the Internet, and in particular of the World Wide Web, many companies have been involved over the last five years in planning and experimentation aimed at leveraging this new technological infrastructure for business purposes [4]. Today, the World Wide Web seems to offer the most potential as a tool for conducting business activities [4]. Firms not only use the Internet to support the exchange of goods, services, information and transactions but certain firms also expect to improve long-term relationships with customers.

There is no widely accepted definition of customer relationship management (CRM) in the scientific community. For the purpose of this paper this definition of customer relationship management will be used: it means being willing and able to change your behavior toward a customer based on what the customer tells you and what else you know about that customer [24]. In fact customer relationship management lets firms to initiate, establish, maintain, and enhance relationships with individual and organizational customers, at a profit, so that the objectives of the parties involved are met; this is achieved by a mutual exchange and fulfillment of promises. The dominating perspective within inter-organizational relationship research has been to assume that customer relationship management has a positive correlation with competitive advantage via customer loyalty.

The general assumption is that the deployment of the Internet's tools would increase switching costs and create strong competitive advantage. Switching costs encompass all the costs incurred by a customer in changing to a new supplier [25]. Firms not pursuing cost-based competitive advantages through the Internet will be left behind [31]. Competitive advantage analysis has provided the foundation for many researches on customer relationships

management [32].

Trust may have an impact on the link between electronic commerce customer relationship management and competitive advantage via customer loyalty because trust is precursor to customer loyalty. Trust has been conceptualized as existing when one party has confidence in an exchange partner's reliability and integrity [5]. Becoming a trusted partner of a customer is a key to maintaining customer relationship management. Trust can be achieved by providing the customer with valuable information using a high quality web site. Certain authors speculate that in the early stages of Internet development, trust is a critical factor in stimulating purchases over the Internet [16] mainly because of security issues, which is one of the Internet's tools used to promote commitment to customer relationship management.

Internet's web tools would not only assist in customer relationship management initiation, it would help in its improvement, and even enhancement, of relationship which leads to increased competitive advantage via customer loyalty [3]. But Loyalty can't be addressed with technology [26]. It isn't simply a matter of having better security or database systems [26]. Without the glue of loyalty via customer relationship management and improvement, even the best-design electronic commerce model will collapse [27]. The effective management of the combination of the Internet's web tools, trust and customer relationship management factors will bring competitive advantage via customer loyalty to firms. In the rush to build Internet for business purposes, it is mistake to think that only a web site is sufficient to retain customers because loyalty is a relationship phenomenon rather than a technological phenomenon. To increase the loyalty of customer via Internet's web tools, you must first use the technology to build lasting trusted long-term relationships.

The objective of this paper is to demonstrate how trust can be applied to support electronic commerce customer relationship management in order to create competitive advantage via customer loyalty. This article consists of two main parts. First, a conceptual model explaining the theoretical linkage between customer relationship management and customer loyalty will be presented and explored. In addition, the impact of Internet's web tools and trust on the linkage between customer relationship management and customer loyalty will be explained. Second, we present theoretical propositions that will underlie future empirical studies examining the impact of trust on the link between electronic commerce customer relationship management and customer loyalty in many industries.

## 2. Conceptual Constructs

A consideration of the study's objective will help to identify its key constructs, such as: the customer

relationship management construct which will play the role of independent variables, competitive advantage construct via loyalty will be the dependent variable, Internet's web tools construct will be considered as the first group of moderating variables and trust will represent in the model, the second group of moderating variables. Each of them is discussed below.

### 2.1 CRM construct components

Relationships are developed between organizations for the exchange of products, services, resources, information and so on [21]. Customer relationship management is generally viewed as processes to exchange goods and services for some form of compensation. Customer relationship management can be based upon networks. Another type of coordination among organizations has been suggested: network [21]. Networks are groups of organizational actors who participate in a general pattern of interaction [21]. Networks can be groups of organizations, but also groups within organizations. The different organizational actors can have their own particular interests, and can be allied to different network-organizations [21]. The primary goal of customer relationship management is to let companies to achieve - through empowerment, interactive management, and partnerships - competitive advantage via loyalty in relation to companies outside the network. Then customer relationship management is heavily dependent upon: empowerment, interactive management and partnerships. Each of them is discussed below.

#### 2.1.1 Empowerment

Empowerment generally refers to the process firms adopt to encourage and reward employees who exercise initiative and make valuable creative contribution [12], or do everything that is possible to help customers solve their problems. Most business representatives prefer to deal with regular customers because they are easy to serve and because they understand the firm's preoccupations [8].

#### 2.1.2 Interactive Management

Interactive management is the key aspect of customer relationship management functions [12]. It comprises all actions designed to transform the prospective client who enters into contact with the business representative into an active and effective customer [12]. It is based on the reciprocity that constitutes one important dimension of customer relationship management [6]. Feedback is part of the core of interactive management [13]. Indeed, [13] consider customer feedback as the step of the customer relationship process assessment and define it as the best way for firms to keep in touch with their customers' perceptions.

#### 2.1.3 Partnerships

Partnerships are created when suppliers work closely with customers and add desired services to their traditional product and service offerings [13]. This means resale of your firm's products and services by your customers. It also means joint development of products and services with customers. To get effective partnership with customers, some suppliers create joint ventures with customers. In other cases, customers refer to your firm's products and services when they sell their own products and services. [33] has developed an integrated model devoted to relationship phases. In this model, partner selection is considered as the first step in the relationship process.

## 2.2 Competitive advantage components

Competitive advantage is the method by which an organization attempts to achieve its mission, aims and objectives [8]. To establish and maintain a distinctive competitive advantage, a firm needs to follow six main principles: 1) it must start with the right goal; 2) a company's strategy has to allow it to deliver a value proposition, or set of benefits, different from those that competitors offer; 3) strategy needs to be reflected in a distinctive value chain; 4) robust strategies involve trade-offs; 5) strategy defines how all the elements of what a company does fit together; 6) finally, strategy involves continuity of direction [25].

Most businesses would prefer their customers become more loyal since it creates customers who are less sensitive to the business efforts of competitors [8]. Similarly, [7] suggested that loyal customers are less likely to switch to a competitor solely because of price, and loyal customers also make more purchases than comparable non-loyal customers. Some researches concluded that building a relationship with loyal customers should be a strategic advantage focus of most firms [7].

### 2.2.1 Loyalty construct

The development of loyalty involves building and sustaining a relationship with a customer that leads to the customer's repeated purchases of products or services over a given period of time. For the purposes of this research, loyalty will be considered as the final result of effective customer relationship management. The purpose is to link loyalty to the emerging theory of customer relationship management [19]. Although many authors, such as [10], distinguish between brand loyalty, store loyalty, salespeople loyalty, product and service loyalty, and so on, in this study the concept of loyalty will be considered as the combination of all these various types. Indeed, some authors, such as [13], have studied the impact of relationship marketing on customer loyalty but have not made any distinctions between different types of loyalty. They have merely specified that their conception of loyalty went beyond the idea of industrial loyalty. A final point to make is that the variable that has been

chosen to measure the competitive advantage in this study is "customer loyalty."

## 2.3 Internet's Web Tool components

Internet's web tools range from simple, associatively linked collections of static hypertext documents to interactive, integrated, customizable solutions and agent-based negotiation support; and since the Internet's web tools were initially developed to address the development of B2C transactions, they can also be effectively applied in B2B settings as well [15]. Today, there are essentially three variables that encompass the construct of Internet's web tools: the level of informational web site, the level of transactional web site and the level of security on the web.

### 2.3.1 The level of informational web site

Commercial web sites provide company information and enable communication with the firm [34]. The informational web site consists of the new Internet-based channels through which companies can display information about themselves and the products and services they offer. Companies can display catalogues of their products. A first category of products which can be efficiently displayed on the web site are products which can be digitalized and transmitted through computer networks. Electronic books, music and video tracks belong to this category. Secondly, the Internet can be used to provide information to customers about physical products such as cars, hardware or perfume etc...

### 2.3.2 The level of transactional web site

The transactional web sites allow customers or trading partners to make a purchase or check the status of an account [34]. The transactional web site consists of the new Internet-base channels through which firms can exchange formal business transactions such as orders, invoices, payments, etc [17]. The transactional web site also encompasses e-mail, two-way interactive communication, virtual community and multimedia capacities because the Internet is a fully interactive communication medium. Therefore firms may use the high level of transactional web site to interact and exchange valuable ideas and experiences, influence opinions, negotiate potential collaborations, engage in relationships, and create different types of communities. In short, the level of transactional web site refers to the extent to which organizations engage in online exchange or communication with others without feeling affected by the constraints of distance and time.

A cookie is a piece of information that allows a Web site to record one's comings and goings. Cookie can help web sites to remember information about customers and respond to their preference. Cookie can facilitate electronic transactions on the web with customers. That means web site containing cookie may enable customers to log in without having to enter a password at every visit.

### 2.3.3 The level of security on the web

One of the greatest concern about doing business on the Internet deals with the level of security in transactions [30]. In the first phase of development, the Internet has not yet been extensively used as a transaction space because of its underdeveloped security aspects [35]. The growth of the electronic commerce is tempered by organizational concern over security and the risk of making transaction process. The perception of unsatisfactory security on the Internet is one of the primary reasons hindering electronic commerce customer relationships management. Despite advances and endeavors in Internet security mechanisms like cryptography, authentication, confidentiality, integrity, non-repudiation, etc... companies are still concerned about using an impersonal transaction medium like the Internet for secure transactions [30].

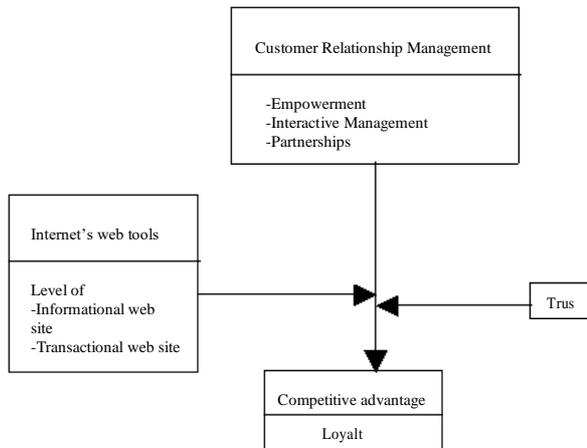
The perceived security of online transactions varies based on the specific payment procedure or money-transfer between organizations. For example, the perceived security of giving corporate credit card information directly over the Web is likely to be different from the risk of setting up a third party account and using that account number in transactions [30]. The parties involved in electronic commerce customer relationship management have to develop together effective security means and to share information about risk in order to motivate their customer participation to online transactions. Also both parties need to secure their web site during their exchange.

### 2.4 Trust

Trust is defined as the firm's belief that another company will perform actions that will result in positive outcomes for the firm as well as not take unexpected actions that result in negative outcomes [2]. Trust is also defined as a willingness to rely on an exchange partner in whom one has confidence [20]. Some companies figure out that building trust leads to more enduring relationships and more profits while a quick sale may simply let a customer leaves the relationships [27]. In inter-organizational relationship context, long-term trust of the seller has been found to be more important than short-term one [16].

The importance of trust becomes evident as a moderator of risk when buyers moves away from buying systems based upon a single transaction to one of repeat purchasers. If the trust is present, such customer relationship management is the basis for a formidable and durable strategic advantage which is measured by customer loyalty in this study [8]. After adopting a specific and more sophisticated measure of loyalty, [8] verified that trust has a causal impact on loyalty. Consistent with conventional logic, we have confirmed that the trust held by a buyer toward a seller is an important antecedent of loyalty, for at least some buying situations in a business environment [8].

## 2.5. The Conceptual Model



## 3. Theoretical Propositions

### 3.1. Theoretical impact of CRM on Customer Loyalty

Berry identifies empowerment as one of the major emerging perspectives in building relationship, this latter leads to customer loyalty [6]. Empowerment means workers can strive to meet customer requirements and needs and resolve problems; that can lead to spontaneous, creative rule breaking to turn a potential frustrated customer into a loyal one [8]. High employee turnover discourages management from investing much in hiring, training, and other relationship-building activities; this, in turn, leads to ineffective loyalty [5]. High employee turnover negatively affects customer retention or loyalty [5]. Recent literature positions employee retention as an antecedent of customer loyalty [5]. It seems that low employee turnover positively impacts customer loyalty.

**Proposition 1a:** The customer relationship management component of empowerment will have a positive and direct effect on customer loyalty.

Berry has noted that for a relationship to exist it has to be mutually beneficial [6]. The interactive management is the dominant business function for building relationship [6] which leads to customer loyalty. Interactive management occurs in the moment of truth when the customer interacts with the organization; it is in these moments of truth that relationships, leading to customer loyalty, are built [6]. Customer Relationship Management is a continuous process, requiring a company to solicit customers' feedback to ensure that their needs are being addressed; a feedback system should let a firm communicate with loyal customers [13]. The feedback

system shows its commitment to learning about and responding to customer concerns [13]. Exchange of regular communication, based on feedback, should determine whether these individuals, groups or organizations as a whole, are able to collaborate [21] and to still loyal to each other. Clearly, feedback refers to situations in which parties share and exchange information to achieve mutual goals in order to maintain their loyal endeavor.

Proposition 1b: The customer relationship management component of interactive management will have a positive and direct effect on customer loyalty.

[23] placed partnership at the extreme end of his loyalty scale, considering it to be the stage when a durable and close relationship between supplier and customer is developed. [33] outlined an integrated model of the relationship marketing process in which the selection of a partner was the first step of effective customer relationship management leading to customer loyalty. Furthermore, the perception of [28] regarding the linkage between partnerships and customer loyalty is the following: customer relationship management was effective when the first step of its process dealing with a partnership leads to the creation of valuable exchanges for both parties involved in the exchange. Obviously, these valuable exchanges were measured in the present study by customer loyalty.

Proposition 1c: The customer relationship management component of partnerships will have a positive and direct effect on customer loyalty.

### 3.2 The impact of the level of informational web site on the link between CRM and Loyalty

[34] show that a majority of firms list their expertise on their web site, including such material as curriculum vitae, important references, and employees' accomplishments. Companies which take such steps empower their employees when they have to negotiate with external customers. This empowerment process has repercussions on the relationships which the employees initiate and maintain with their customers in order to get their loyalty. Companies' contact employees are able, via the web site, to access information about their company and its products and services. A web site, then, is a tool for employee empowerment. This employee empowerment has beneficial effects which affect external customers and ultimately lead directly to their loyalty. Once employees are well informed about their company's web site content, the customers will most likely be satisfied with their services and so loyalty will develop.

Proposition 2a: The level of informational web site will be positively associated with the link between the

customer relationship management component of empowerment on the one hand, and customer loyalty on the other.

The use of electronic feedback links between firms can reduce the costs of maintaining relationship which impacts on customer loyalty. Informational web sites are used not only to facilitate interaction and feedback but also to tightly couple processes at the interface between stages of the link between customer relationship management and customer loyalty. The time taken to download graphics must also be taken into account when considering the degree to which web sites support the link between interactive management and customer loyalty. If customers have to wait too long before they can actually begin to use a vendor's web site because the graphics are too heavy, it will discourage them from exploring the web site further. A customer's frustration at moments like these will prevent the development of an interactive management. On the other hand, if the web pages appear rapidly, customers will feel like exploring the whole site in order to learn more about the company. As such, they will be ready to become involved in a durable relationship with the owner of the site, and thus loyalty will develop.

Proposition 2b: The level of informational web site will be positively associated with the link between the customer relationship management component of interactive management on the one hand, and customer loyalty on the other.

According to [22], informational web site is international by definition because web sites allow a company to attract international consumers. To this argument it is added that business globalization is supported by such an opportunity. Partnerships between firms from different countries are a common occurrence. Another argument is that a web site presented in many languages and available 24 hours a day will help to develop stronger links between companies and their customers. Ozer' [22] arguments mentioned above enable us to understand the reasons why informational web site should foster the link between partnerships and customer loyalty. A further explanation of this theoretical link is that a company's web site which presents its partners' logos induces the partners to stay for a long time with this particular company. The same thing occurs when a company presents on its web site the accomplishments of its partners. Companies also have the option of including on their web site, by external hyperlinks, connections to their partners' web sites. Companies which display their partners' web sites on their own web site will encourage them to be loyal.

Proposition 2c: The level of informational web site will be positively associated with the link between the customer relationship management components of partnerships on the one hand, and customer loyalty on

the other.

### 3.3 The impact of the level of transactional web site on the link between customer relationship management and loyalty

In fact, one study has claimed that companies often empower one or several employees to answer questions or to make comments online [9]. These actions are carried out by e-mail or through online discussion (online conferences, forums, or chat rooms) and allow companies and customers to make the most of the online contact time provided by the Internet to share their views. Companies empower their employees who react online promptly to customer complaints. The companies provide appropriate training for their employees in order to be able to offer various services, solutions, or products during interactive online contact with the customers and to modify, on the screen, the customer relationship management statements that companies use to convince customers to buy on the basis of customers' reactions and views. The home page tries to convince customers to accept the firm's position in regard to certain circumstances [9]. The use of these different tools should create customer loyalty. Likewise, these methods give value to employees and empower them during their contact with customers thus leading to an increase of customer loyalty.

Proposition 3a : The level of transactional web site will be positively associated with the link between the customer relationship management component of empowerment on the one hand, and customer loyalty on the other.

There are forms on the Internet's web that enable the customers to evaluate and appreciate the service offered by the business representatives. Feedback is one of the major components of the definition of interactive management, which leads to customer loyalty and at present, there is no better tool than the web to enable customers to give feedback. The interactive management is based on one-to-one dialogue between business representative and customer, web site tools, such as forums, news groups or chat rooms should support these dialogues; this way of interacting with customers should increase their loyalty.

Proposition 3b : The level of transactional web site will be positively associated with the link between the customer relationship management component of interactive management on the one hand, and customer loyalty on the other.

The business representatives share ideas, influence views, and establish partnership potential, through news groups, forums, and e-mail, with their customers. Such ways of doing business leads firms to develop customer loyalty. Firms involved in virtual exchange, via

transactional web site, should be motivated to become loyal to another if the partnership is based on a "win-to-win" relationship. When firms are committed to a partnership, they will include on their web site a link to the site of their partner. Such a web site will contain forms, e-mail, and so forth, which favor transactions. It is to be expected that this kind of relationship should result in loyalty. In conclusion, the partnership supported by the transactional web site should increase the loyalty between partners.

Proposition 3c : The level of transactional web site will be positively associated with the link between the customer relationship management component of partnerships on the one hand, and customer loyalty on the other.

### 3.4 The impact of the level of security on the web on the link between CRM and Loyalty

Firms that empower their employees to respond and listen to customer needs and requirements have satisfied customers, and develop strong relationships that lead to customer loyalty [13]. The company's web site protected by a secured firewall can be used to enhance the communication and collaboration among authorized employees. When the secured firewall protects the company's Internet, it becomes Intranet. The firewalls protect the intranets from unauthorized outside access. Only authorized employees are able to use them because they are limited to information pertinent to the company and contain exclusive and often proprietary, sensitive and strategic information. Company that uses the intranet (the secured private internet) to support their employees will increase their customer loyalty.

Proposition 4a : The level of security on the web will be positively associated with the link between the customer relationship management component of empowerment on the one hand, and customer loyalty on the other.

Using secure web technology such as digital signatures and digital certificates can help a company to establish and maintain interactive management relationships leading to customer loyalty. Digital certificates are used for many different types of online transactions, including electronic mail and electronic funds transfers. In fact a web site's digital certificate is a business assurance that the web site is this one of his customer and not an imitator. Because digital signatures offer a way to verify party's identity, buyers and sellers can use them to verify each other before beginning their interactive management, making it a bit easier for them to become loyal to each other.

Proposition 4b : The level of security on the web will be positively associated with the link between the customer relationship management component of

interactive management on the one hand, and customer loyalty on the other.

Businesses engaging in online partnership need to feel that their transactions are secure from prying eyes and safe from alteration. For example, a business-to-business extranet web site is a secured business network of several partners that become loyal to each other. Because of the security issue, organizations that are willing to do online business have to make concerted efforts to allay fears by offering clear security guidelines to their partners and vice versa. Both partners involved in a customer relationship management must develop effective security together and share information about risk in order to motivate participation in online transactions and to trigger their loyalty.

Proposition 4c : The level of security on the web will be positively associated with the link between the customer relationship management component of partnerships on the one hand, and customer loyalty on the other.

### 3.5. The impact of Trust on the link between electronic commerce customer relationship management and Loyalty

Trust is the necessary component that binds two parties together, moderates their risk, and implicitly guarantees their future benefits [8] such as loyal to each other. Parties can use trusted extranet to support their employees to share contract information and shipment and payment status. When customers trust an on-line business representative, they will share sensitive information with him; that information enables the company to form a more intimate relationship with customers, offering products and services tailored to their individual preferences, which in turn increase trust and strengthen loyalty [27]. Such way of doing business can quickly translate into a durable advantage over competitors [27]. Also, the internal management of production, inventory, procurement etc... can be supported by the trusted intranet functions and these functions can also be seamlessly integrated with the extranet. Parties can trust extranet connectivity because it provides secured connectivity between a corporation's intranet and the intranet of its supplier. The trusted environment of the extranet allows groups of employees to collaborate, sharing information exclusively and exchanging it securely. Since an extranet allows connectivity between businesses through the Internet, it is an open and flexible platform suitable for customer relationship management which yield customer loyalty.

Proposition 5a: Trust will be positively associated with the link between electronic empowerment and customer loyalty.

In the setting of electronic commerce, parties must trust each other before they interact and exchange.

Customer loyalty stems from continued interaction between the parties in the relationship. As long as the businesses provide interactive management of value based on their Internet's web tools to their customers, they are likely to be treated as trusted companies. In fact, business is based on trust between two parties, whether the business is conducted in person, by phone, or over a web site. The customer can get a sense of the company and the person from face-to-face discussions or from the appearance and location of the office; but this element of trust is difficult to reconstruct in electronic interactions because all the customer knows about the supplier is what can be seen on the web site. Therefore, creating trust via the Web depends on fostering interactive management through electronic means of well-established Internet's web tools. When companies treat the web as more than just a communication tool, the trust between companies will grow, a customer relationship management will be developed and maintained, and customer loyalty will be developed.

Proposition 5b: Trust will be positively associated with the link between electronic interactive management and customer loyalty.

Trust can be seen as a belief, sentiment, or expectation about a partner that results from a partner's expertise, reliability, or past behavior [8] [7]. The partnership relationship is characterized by a high-level of trust [7]. Companies are fascinated by international partnership opportunities on the Web, but they are skeptical about actually purchasing from overseas sites [16]. The international aspect of the Internet further challenges engendering trust in a partner relationship. [8] verified that trust has a causal impact on loyalty.

Proposition 5c: Trust will be positively associated with the link between electronic partnerships and customer loyalty.

## 4. Conclusion

The objective of this paper is to propose a model to test the effect of Internet's web tools and trust on the link between customer relationship management and competitive advantage via customer loyalty. Internet's web tools such as level of informational web site, level of transactional web site and level of security on the web can support the formation and maintenance of customer relationship because they facilitate the way organizations partner, interact and empower. In other words, Internet's web tools can let organizations to build tight relationships with their trading customers who should become loyal to them, rather than to select customers on a transaction by transaction basis from a large pool of non-loyal ones. The quality of web site infrastructure can directly influence the type of customer relationships management developed between firms who desire to be loyal reciprocally.

One more issue that is central to electronic commerce is the level of trust that is necessary before businesses may commit to an electronic commerce customer relationship management leading to customer loyalty. First of all many authors argued that the construct of trust is an important element of long-term buyer-seller relationships in a business environment [8]. Also, customer loyalty is a relationship built on trust between the buyer and the seller [7]. Second, trust is not only a short-term issue but the most significant long-term barrier for realizing the potential of electronic commerce on the Internet [16]. Lastly, with trust as a precursor, a customer becomes loyal to a firm [7]. In fact, trust has a direct or indirect impact either on the Internet's web tools or on the customer loyalty or on the customer relationship management or on the relations among these three constructs.

The theoretical discussion of this study will allow experts on information systems and the Internet to inform business representatives about the theoretical impact of trust on electronic commerce customer relationship management. These experts have to demonstrate to the business representative methods of fixing customer loyalty objectives when they are theoretically supported in their customer relationship management tasks by the level of informational web site, the level of transactional web site and the level of security on the web provided by the Internet to their companies.

Future research is necessary because the theoretical propositions presented in this paper must be tested. In fact, continual research is needed because Internet technology evolves so rapidly and said evolution will likely effect the relationships tested by this model's propositions. Additional research should also expand the range of Internet's web tools variables and examine their effects on the link between customer relationship management and organizational performance.

## References

- [1] Adelaar, T. "Electronic Commerce and the Implications for Market Structure: The Example of the Art and Antiques Trade," *Journal of Computer-Mediated Communication*, 2000, 5(3), [Online].
- [2] Anderson, J. C. & Narus, J. A., "A Model of Distributor Firm and Manufacturer Firm Working Partnership," *Journal of Marketing*, 1990, 54(1), 42-58.
- [3] Avlonitis, J. G. & Karayanni A. D., "The Impact of Internet Use on Business-to-Business Marketing," *Industrial Marketing Management*, 2000, 29(5), 441-459.
- [4] Bell, H. & Tang, N. K. H. "The effectiveness of commercial Internet Web sites: a user's perspective," *Internet Research: Electronic Networking Applications and Policy*, 1998, 8(3), 219-228.
- [5] Berry, L. L., "Relationships Marketing of Services- Growing Interest, Emerging Perspectives," *Journal of Academy of Marketing Science*, 1995, 4(23), 236-245.
- [6] Bitner, J. M. "Building Service Relationships : It's All About Promises," *Journal of Academy of Marketing Science*, 1995, 23(4), 246-251.
- [7] Bowen, J. T. & Shoemaker, S. "Loyalty: A strategic Commitment," *Cornell Hotel and Restaurant Administration Quarterly*, 1998, 12-25.
- [8] Chow, S. & Holden, R., "Toward An Understanding Of Loyalty: The Moderating Role Of Trust", *Journal of Managerial Issues*, 1997, 9(3), 275-298.
- [9] Dholakia, U. M. & Rego, L., "What makes commercial Web pages popular? An empirical investigation of Web page effectiveness," *European Journal of Marketing*, 1998, 32(7), 724-736.
- [10] Dick, A. S. & Basu, K., "Customer Loyalty: Toward an Integrated Conceptual Framework," *Journal of the Academy of Marketing Science* 1994, 22(2), 99-113.
- [11] Dickson, P. R., "Understanding the Trade Winds: The Global Evolution of Production, Consumption, and the Internet," *Journal of Consumer Research*, 2000, 27(1), 115-122.
- [12] Dufour, J-C. & Maisonnas, S. *Marketing et Services: Du transactionnel au relationnel*, Les presses de l'Université Laval, Sainte-foy, Qc., 1997, 210p.
- [13] Evans, J. R. & Laskin R. L., "The Relationship Marketing Process : A Conceptualization and Application," *Industrial Marketing Management*, 1994, 23(5), 439-452.
- [14] Gartner Group, "GartnerGroup Forecasts Worldwide Business-to-Business E-Commerce to Reach \$7.29 Trillion in 2004," press release, 2000 (available at <http://gartner11.gartnerweb.com/public/static/aboutgg/pressrel/pr012600c.html>)
- [15] Gebauer, J. & Scharl, A. "Between Flexibility and Automation: An Evaluation of Web Technology from a Business Process Perspective," *Journal of Computer-Mediated Communication*, 1999, 5(2), [Online].
- [16] Jarvenpaa, S. L. & Noam, T., "Consumer Trust in an Internet Store: A Cross-Cultural Validation," *Journal of Computer-Mediated Communication*, 1999, 5(2), [Online].
- [17] Joseph, V. B., Cook, R.W., & Javalgi R. G., "Marketing on the Web : How Executives Feel, What Businesses Do," *Business Horizon*, 2001, 44(4), 32- 40.
- [18] Lancioni, A. R., Smith, F. M. & Olivia, A. T. "The Role of the Internet in Supply Chain Management," *Industrial Marketing Management*, 2000, 29(1), 45-56.
- [19] Macintosh, G. and Lockshin L. S. "Retail relationships and loyalty: A multi-level perspective," *International Journal of Research in Marketing*, 1997, 14(5), 487-497.
- [20] Morgan, R. M. & Hunt, D. S. "The Commitment-Trust theory of Relationship Marketing," *Journal of Marketing*, 1994, 58(3), 20-38.
- [21] Nouwens, J. & Bouwman, H., "Apart Together In Electronic Commerce: The Use Of Information And Communication Technology To Create Network Organizations," *Journal of Computer-Mediated Communication*, 1995, 1(3), [Online].
- [22] Ozer, M., "Information Technology and New Product Development," *Industrial Marketing Management*, 2000, 29(5), 387-396.
- [23] Payne, A. "Relationship Marketing Making the Customer Count," *Managing Service Quality*, 1994, 4(6), 29-31.
- [24] Peppers, D., Rogers, M. & Dorf, B., "Is Your Company Ready For One-to-One Marketing," *Harvard Business Review*, 1999, 66(1), 151-160.
- [25] Porter, M. E. "Strategy and the Internet," *Harvard Business Review*, 2001, 79(3), 63-78.
- [26] Reichheld, F. F., "Lead for Loyalty," *Harvard Business*

Review, 2001, 79(4), 76-84.

[27] Reichheld, F. F. & Scheffer P, "Your Secret Weapon on the Web", Harvard Business Review, 2000, 78(4), 105-113.

[28] Shultz, D. H. "Marketing Consulting Services on line," Journal of Management Consulting, 1995, 8(4), 35-42.

[29] Sung-Joon, Y. and Joo-Ho, K. "An empirical validation of a loyalty model based on expectation disconfirmation", Journal of consumer marketing, 17(2), 2000, 120-136.

[30] Swaminathan, V., Lepkowska-White E., & Rao B. P. "Browsers or Buyers in Cyberspace? An Investigation of Factors Influencing Electronic Exchange", Journal of Computer-Mediated Communication, 1999, 5(2), [Online].

[31] Venkatraman N, "Five Steps to a Dot-Com Strategy : How To Find Your Footing on the Web," Sloan Management Review, 2000, 41(3), 15-28.

[32] Wathne, K. H. & Heide, J. B. "Opportunism in Interfirm

Relationships: Forms, Outcomes, and Solutions," Journal of Marketing 2000, 64(4), 36-51.

[33] Wilson, T. D. "An Integrated Model of Buyer-Seller," Journal of Academy of Marketing Science, 1995, 23(4), 335-345.

[34] Young, D. & Benamati, J, "Differences in Public Web Sites: The Current State of Large U.S. Firms," Journal of Electronic Commerce Research, 2000, 1(3), 1-19.

[35] Zwass V. "Structure and macro-level impacts of electronic commerce from technological infrastructure to electronic marketplaces,"

<http://www.mhhe.com/business/mis/zwass/ecpaper/html>,

January 1998, consultation date : 11/30/98, 24 pages. It will publish in Emerging Information Technologies, Kendall and Kendall (eds.), Thousand Oaks, CA : Sage Publications.



# Why are Self-Service Customers Loyal? -- A Relational Benefits Perspective

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## Abstract

Self-service technology has been growing popular for current business practice to increase productivity and reduce cost. Issues regarding impacts of lacking human touch in technology-based interaction on jeopardizing customer relationship, however, has remained unanswered. The current study applied attribute-based model of SST and customer relational benefits model to address the concern of SST introduction and possible changes in customer relationship. A survey was conducted to test the impacts of Web-based self-service attributes on customer loyalty, and the possible mediating role of relational benefits. The results generally suggested that certain attributes of Web-based self-service are important at enhancing perceived relational benefits. Positive perceptions of confidence benefits, social benefits, and special treatment benefits obtained from the Web-based service provider resulted in higher customer loyalty. The implications of the research findings were discussed.

## 1. Introduction

The advances of information technology have brought dramatic changes in services business. More companies are offering and encouraging customers to use self-service technology which might provide substantial benefits for the firms in terms of improving productivity and cost saving (Lovell and Young, 1979; Schneider and Bowen, 1985). Consumers would choose the self-service technology (SST) option when they hold a positive attitude for enjoyment and control attributes of the SST option (Dabholkar, 1996). There are various types of SSTs interfaces, including telephone-based technologies, interactive voice response systems, direct online/Internet-based interfaces, interactive free-standing kiosks, and video or compact disc (CD) technologies (Meuter, Ostrom, Roundtree, and Bitner, 2000). The present study focus on Web-based self-service (WBSS) which is getting more prevalent recently.

It is worthy noting that the omission of interpersonal contact in the various SST interfaces could become a risk when firms implement SSTs. In fact, the interpersonal aspects of a relationship are at times found to be more important than the occasional price breaks or special service (Gwinner, Gremler, and Bitner, 1998). Therefore, it is possible that customers may become less loyal to the

relationship if the social bond between service employee and customers is weakened in the self-service technology interface. Despite of the potential risk on customer loyalty, more and more firms are motivated to introduce SSTs for a variety of advantages such as increased availability (Lovell, 1983), timesaving, and ease of use (Meuter et al., 2000). On the other hand, building strong customer relationships as a means for gaining a competitive advantage is also gradually emphasized (McKenna 1991; Reichheld, 1993). Therefore, it will be important for firms to find out how would the introduction of SSTs impact customers loyalty.

Customers would stay in a relationship if they receive certain benefits (Gwinner et al., 1998). Customers in long-term relationship normally experience three primary types of benefits beyond core service benefits, including confidence benefits, social benefits, and special treatment benefits (Gwinner et al., 1998). Could these relational benefits applied to explain customer relationship in self-service context?

Based on the above discussion, the current study aims to address the following research issues in the WBSS context. First, what are the attribute of WBSS that are influential for strengthen relational benefits? Second, are the three relational benefits important precursors of customer loyalty to Web-based service provider? Finally, this study proposed that relational benefits are important constructs mediating the relationship between WBSS attributes and customer loyalty.

## 2. Theoretical Background

Technology-based interaction is gradually becoming a popular option for service encounter, and as a critical source of influences on long-term customer relationship. In a marketspace where "products and services exist as digital information and can be delivered through information based channels" (Rayport and Sciokla, 1995, p 14), customers were not served by front-line personnel. Therefore, self-service technologies represent a typical transactional form in which no interpersonal contact is required for service encounter. During the encounter, customers using self-service technology are viewed as "partial employees" to serve themselves, and their evaluations of attributes associated with SST could be crucial in determining consumers' continuance of SST usage. The current study builds upon the attribute-based

model of SST (Dabholkar, 1996) and proposes attributes as important antecedent of customer relational benefits in the context of Web-based self-service. In specific, perceived performance, perceived efficiency, enjoyment, perceived control, and customization are suggested as significant factors in customer relationship management.

Positive outcomes gaining from strong customer relationship have been well documented in the literature (e.g., Aaker, 1992; Clark and Payne, 1994; McKenna, 1991; Reichheld, 1993; 1996), but studies regarding the relationship benefits are primarily approached from the perspective of the firm (Gwinner et al., 1998). On the other hand, customers also need to benefit either from the core product/service or from the relationship to remain loyal to a firm. This is particularly true since most products and services are offered by more than one firm (Hennig-Thurau, Gwinner, and Gremler, 2000). Grounded upon previous work on customer relational benefits (Barnes, 1994; Bendapudi and Berry, 1997; Berry, 1995), Gwinner et al., (1998) developed and empirically examining the typology of relational benefits. They suggested that customers in long-term relationship normally experience three primary types of benefits beyond core service benefits; namely, confidence benefits, social benefits, and special treatment benefits (Gwinner et al., 1998).

The first type, titled confidence benefits by Gwinner et al., (1998), describes the advantages of long-term relationship at reducing uncertainty in transactions and increasing realistic expectation for service encounter. The second type, social benefits, describes the emotional aspects of the relationship and focuses on personal recognition of customer by employees and the development of friendship between customers and employees. The third type of benefit contains both economic benefits and customization benefits and was titled as special treatment benefits by Gwinner et al., (1998). Advantages such as price breaks, fast services, individualized treatment are the special treatment benefits one normally received from staying in a long-term relationship. As the development of each type of relational benefits might be related to direct personal contact to a more or less extent, whether customers perceive any relational benefits from being loyal to a particular technology-based service provider remains unknown.

The infusion of Internet technology into services can improve customer relationship (Walsh and Godfrey, 2000). The advances of technology enhance customer relationship by automatically and effortlessly collecting, analyzing, and utilizing customer information. The Internet-based technology also provides the firm a convenient and powerful tool to interact closely with customers over time to establish a personal and more intimate relationship. Despite of these relationship marketing practices, customers still want quality services from technology-based service providers just as they always want (Bitner, 2001). While WBSS attributes might

characterize the technology-based service encounter for consumers, the performance of these attributes could subsequently form perceived relational benefits of staying with a particular technology-based service provider. The current study proposed that performance of each WBSS attributes would result in distinct relational benefits for customers.

### *2.1 Hypothetical Model*

The relationship between the four WBSS attributes and relational benefits are proposed in the following. The first attribute, perceived performance, is derived from the concept of usefulness. Perceived usefulness refers to user's belief about the probability of increasing job performance by using a specific computer software (Davis et al., 1989). The nature of perceived usefulness might not be an attribute applicable to the context of SST usage. Instead, Dabholkar (1994) proposed "performance" as an attribute replacing perceived usefulness, and is conceptualized to encompass the perceived reliability and accuracy of self-service technology. The literature has identified reliability as an important dimension to evaluate service quality (e.g., Parasuraman, Zeithaml, and Berry, 1988; Van Gorder, 1990). A similar dimension, "did its job", was found in another study as a factor relevant to consumer satisfaction with SST (Meuter et al., 2000). The capability to perform the intended task is predicted to enhance the confidence of using Web-based self-service. Therefore, it is predicted that perceived performance in using WBSS will be positively associated with confidence benefits.

The second attribute, perceived control, refers to the amount of control customer feels that she or he holds over the process or outcome of a service encounter (Dabholkar, 1996). Perceived control is important for self-service users (Langeard, Bateson, Loverlock, and Eiglier, 1981) and they often chose to use this option to feel in control during the process (Bateson, 1985). Consumers also feel satisfied with SST because this option enables them to acquired needed service without having to contract with service personnel (Meuter et al., 2000). Therefore, SST allows some customers the alternative to regain the control by performing the tasks usually conducted by service employees. Accordingly, the greater control one perceived in using WBSS, the more likely one feel confident of using the option. Accordingly, perceived control is hypothesized to have a positive and direct effect on perceived confidence benefits.

The third attribute, enjoyment, was considered as a characteristic capturing customer perception of SST (Dabholkar, 1994) or a determinant on technology usage (Webster, 1989). Dabholkar's study (1996) also discovered enjoyment as a determinant of SST service quality and intention to use SST option (Dabholkar, 1996). The literature suggested that interaction intensity and utilitarian value of the relationship are relevant to the development of social bonds (Selness and Hansen, 2001). When customers feel that it is fun to deal with a service

provider, the relationship become more enjoyable to customers (Gwinner et al., 1998). Thus, likeability of particular Web-based service provider might increase as the enjoyment of interaction escalates, which then become a good base for developing social benefits. In other words, positive affect derived from using WBSS of certain service provider could transform into the emotional aspect of the relationship and facilitate perceived social benefits of relationship. Consequently, enjoyment is hypothesized to have a positive and direct effect on social benefits.

The fourth attribute, customization, refers to the freedom to personalize the use of self-service devices in terms of time and location. Also, customization is conceptualized as the belief that WBSS offers users another option to acquire the services at their personally preferred manner. For example, some Website offer the storage that customers may place their preferred items and decide later whether they want to purchase. This option may be especially important for certain consumers and is an attribute unique in WBSS to satisfy personal shopping needs. The concept of this attribute is similar to the “when I want” and “where I want” sub-dimensions emerged in the critical incidents study by Meuter et al., (2000), and the “convenience” factor as one antecedent of e-satisfaction in a study by Szymanski and Hise (2000). The present study suggests that the attribute, customization, represent an unique offer of utilitarian value satisfy customer personal preference. And the capability to satisfy individual needs might bring positive affect to the relationship and strengthen the perception of social benefits. Therefore, it is hypothesized that customization will both have positive effects on perceived social benefits.

In addition, the nature of customization to offer special features that meets individual preference would be the characteristics most relevant to special treatment benefits. Although the nature of around-the-clock access seems to be fundamental for Internet, some technical breakdown and other maintenance problem could erode the fulfillment of customization. Therefore, we proposed that perceived customization would have a positive effect on perception of special treatment benefits.

The last attribute, perceived efficiency, is the speedy nature of WBSS to solve users’ needs than other service options. Meuter et al., (2000) found that the character to solve intensified need is the first factor determining users’ satisfaction with SST. When consumer expected a long waiting time for receiving services, the speed of delivery in SST become an important factor (Dabholkar, 1996). The fact that consumer can use Web-based self service to satisfy their needs in a fast manner could become a special benefit that customers received from using WBSS. Thus, perceived efficiency of using WBSS is predicted to have a positive effect on special treatment benefits.

Positive relationships between the three types of relational benefits and customer loyalty related constructs have been reported in previous studies (Gwinner et al., 1998; Hennig-Thurau, Gwinner, and Gremler, 2002). Regardless of the service types, confidence benefits are

believed to be the most important type of benefits (Gwinner et al., 1998), and its effects on loyalty primarily occur through satisfaction (Hennig-Thurau et al., 2002). Compared with the direct and significant effects of social benefits on customer loyalty, the direct effects of special treatment on loyalty have not received consistent support (Hennig-Thurau et al., 2002). Due to the nature of Web-based self-service, the impacts of the three types of relational benefits might function in a slightly different pattern. In specific, security and privacy issues of online transaction are still primary concerns for consumers (need supporting reference), perception of confidence benefit is predicted to have a positive effect on intent to stay in the relationship.

On the other hand, the practices of data mining and warehousing technique to record and analyze customers’ shopping behaviors allow the Web-based service providers the opportunities to provide customized offers to their customers. The information can also be utilized by Web-based service providers to present recommendations particularly fitting into customers’ interests and needs e at the real-time interaction. These performances all represent special treatment benefits that customers could experience with Web-based service provider, and is predicted to have a positive effect on intent to stay in the relationship. Finally, although the emotional element and friendship that usually exist between customers and employees are difficult to imitate, friendly treatment of the Web-based service provider toward the customers may be perceived as a social benefit to the customers. For customers who are familiar with certain Web-based self-service may see the interface as so enjoyable and become another channel for their social life, which further nurture the social benefits of using WBSS and its effect at enhancing customer loyalty.

In sum, there are 9 hypotheses proposed for the current study:

*Hypothesis 1: Perceived performance in using WBSS will have a positive effect on perception of confidence benefits.*

*Hypothesis 2: Perceived control of using WBSS will have a positive effect on perception of confidence benefits.*

*Hypothesis 3: Enjoyment in using WBSS will have a positive effect on perception of social benefits.*

*Hypothesis 4: Customization in using WBSS will have a positive effect on perception of social benefits.*

*Hypothesis 5: Customization will have a positive effect on perception of special treatment benefits.*

*Hypothesis 6: Perceived in using WBSS will have a positive effect on perception of special treatment benefits.*

*Hypothesis 8: Confidence benefits are expected to have a positive impact on customers’ intent to stay*

*in the relationship.*

*Hypothesis 9: Social benefits are expected to have a positive impact on customers' intent to stay in the relationship.*

*Hypothesis 9: Special treatment benefits are expected to have a positive impact on customers' intent to stay in the relationship.*

### **3. Research Methods and Analyses**

A self-administrated, cross-sectional survey was conducted with 459 respondents across two service industries (i.e., travel agency and bookstore). The two types of services were selected due to their distinction on contact levels. According to the taxonomy of service firms by Bowen (1990), travel agency is classified as a high contact service type and books retailing is conceptualized as moderate contact because usually standardized services are offered in bookstore. While the services are offered on the Web, the level of contact embedded in the nature of the two service industries could both be transformed into low customer contact. Consequently, customers in the two service industries might go through distinct degree of adjustment when they move from full service to self-service on the Web. It would be interesting to understand whether the reasons to be loyal self-service customers are identical for the two service types of distinct contact level.

Perceived attributes of Web-based self-service (WBSS), customer relational benefits, and loyalty were all assessed with 7-point Likert scales ranging from 1 (strongly disagree) to 7 (strongly agree). Measurement of WBSS attributes were adopted from Debholkar's study (1996) and modified to tap the nature of Web-based self-service. The scale developed by Gwinner et al., (1998) to assess the three relational benefits were revised for current study to capture the nature of the two service industries and the characteristics of WBSS. Confirmatory factor analyses performed for the two sets of constructs indicated a good fit of the measurement models to the data (both CFIs  $\geq .952$ , both GFIs  $\geq .959$ , both TLIs  $\geq .920$ ). The results also supported the measures applied in the present study appropriate measures of WBSS attributes and relational benefits.

To address the three research issues, structural equation modeling was performed to test the relationship between WBSS attribute evaluation and relational benefits, and between relational benefits and customer loyalty. The analyses revealed a good fit of the hypothesized model to the data ( $\chi^2=490.895$ ,  $df=170$ ,  $p<.001$ ; CFI=.910,

GFI=.910). The parameter estimates showed that perceived performance and perceived control in using WBSS had significantly positive effects on confidence benefits. More positive social benefits resulted from more favorable evaluations on enjoyment and customization of WBSS, and special treatment benefits are positively associated with efficiency and customization of WBSS option. In conclusion, the six hypotheses regarding WBSS attributes and relational benefits were confirmed.

In addition, the analyses also showed that all three types of relational benefits had significantly positive impacts on customer loyalty. That is, hypothesis 7, 8, and 9 are also supported in the current study. A comparison of the hypothetical model with a saturated model containing both direct and indirect effects of WBSS attributes on loyalty suggested that relational benefits are important mediators between WBSS attributes and customer loyalty.

### **3. Conclusion and Discussion**

While previous studies suggested that cognitive evaluation of SST attribute would influence consumers' intention to use self-service technology, none of these empirical studies attempted to investigate the impacts of these attributes on consumers' loyalty. This study built on the attribute-based model of SST and customer relational benefits model to study factors determining customers' loyalty in the context of Web-based self-service. The study in general suggested that WBSS attributes offers explanations for reasons that customer are willing to be loyal to a service provider as the contact is technology-based. In specific, when the Web-based self-service device is evaluated as efficient, controllable, enjoyable, capable, and customized to meet personal needs, customer are willing to stay loyal to the Web-based service provider although no contact personnel is present to establish the social bonding. This study is also important to provide evidences to show that social benefits are still important for consumers although there is no human touch in the WBSS. More importantly, social benefits in technology-based interaction can be developed through certain design of the SST device. These findings would be very important for companies that are planning to offer customers Web-based self-service as an option for service encounter.

### **4. References**

References are available upon request.

# CRM Implementation in PR China: A Preliminary Evaluation

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## Abstract

The scope and nature of Customer Relationship Management (CRM) implementation in Chinese enterprises is examined to identify the focus of implementations, areas of implementation, implementation strategies and perceived benefits of a convenience sample of cases selected from business press reports. The study also looks at what Chinese managers view as the key CRM concepts for beneficial performance.

## 1. Introduction

CRM implementation has been shown to be very successful in increasing the level of customer satisfaction and capable of increasing the retention of existing customers over time. Following its enthusiastic acceptance in western countries, the developing markets and the markets in transitioning economies are seeking to reap the same benefits by embracing the principles of CRM. A rough product life cycle analysis of CRM market in China shows that after a slow introductory phase in the late 1990s, it is now in a growth phase starting with 2001, the downturn in the internet and communication related industries notwithstanding [1]. Multinational companies introduced CRM into P.R. China as a tool to gain a foothold in the potentially vast market that also featured major domestic constraints and strong international competition. The early domestic entrants into the Chinese CRM market have been the burgeoning SME sector. These companies also tend to be private entities, who are in very competitive markets. Initially the focus was on software implementations that were fast and furious. Only now are companies looking more seriously at putting in place structural changes that will add teeth to their efforts at becoming serious about identifying, managing and nurturing relationships with their customers. The geographic coverage of CRM implementation is predictably in the industrialized east, and service sector implementers far outnumber their counterparts in manufacturing.

This study will look at the differences and similarities in characteristics of CRM implementation in P.R. China relative to that in developed western economies. The problems and obstacles to implementing CRM in Chinese markets will be examined. Finally, the results of a pilot study on implementation focus for CRM in China will be

reported.

## 2. Western vs. Chinese Models of CRM

The standard CRM methodology for implementation is a) strategy, b) segmentation, c) technology, d) process and e) organization. Companies following this model in the west have tried to follow this general sequence more often than not. CRM implementation starts with an assessment of the business environment in some variation of a SWOT (strengths, weaknesses, opportunities and threats) analysis. The analysis identifies the triggers for CRM implementation both within the organization and in the external environment. This analysis also is likely to focus on a medium to long term planning horizon, and include an analysis of the environment faced by key business partners beyond the traditional business functions. The output of this stage is a mission/vision statement that specifies the role of CRM in the business model of the organization.

The second stage of the implementation strategy develops a segmentation map of the organization's customers as they contribute to the stated goals and objectives of the organization. While this is usually some objective measure of profitability, it can also include measures of other non-financial indicators of business performance. The pareto type analysis identifies the group/s of customers who contribute the most to the success of the mission. The information and segmentation output are then used to guide the deployment of scarce resources to managing relationships with those customers where the likelihood productivity increase is the highest.

The third stage consists of identification and deployment of available technology to achieve desired process improvements that are necessary for achieving the CRM deployment. The focus is on defining system requirements, assessment of system requirement criteria and vendor assessment and selection criteria. The training of personnel with responsibilities of using the technology is critical in this phase, as is the smooth adaptation and/or migration of operations to the new system. The most important strategy here is to run a pilot rather than to push through radical organization wide change.

In the fourth stage, the results of the pilot are carefully evaluated. If positive, diligent planning is conducted to identify how the CRM strategy can be migrated to all processes of the organization. This will involve integrating the technology to all the processes with a

common goal of enhancing CRM features.

The final step is to re-engineer the structure of the organization and review the allocation of roles, responsibilities and functions of personnel at all level of the organization. Simultaneously, appropriate training of personnel to enable and empower them to discharge their new roles and responsibilities will be undertaken.

The whole organization will need to buy into a commitment to continuously review the CRM implementation and incorporate adjustments when warranted.

The Chinese model of CRM implementation has, so far, deviated substantially from the model outlined above.

As with many other facets of the market, the Chinese have explicitly linked CRM implementation to the WTO entry and subsequent changes in economic landscape. The CRM implementation is for the specific outcome of “increased sales.” The short-circuited causal model bypasses the need to understand the mechanism through which the outcome is achieved, and provides no incentive to focus on the necessary intermediate steps, additional inputs and environmental conditions that are also needed to ensure the outcome desired.

The pre-transition Chinese economy that ran on a socialist model was driven by allocations determined at various levels of the bureaucratic hierarchy. As such, no explicit role of customer in the “marketing” efforts. The end-result of this policy was that virtually no research was conducted on the customer side of the business.

The early ERM implementation in China was a radical departure from the selling oriented system. The multinational enterprises were unable to apply their developed strategy because of difference in market structure. In China their customer was primarily the government, or state agencies that served as buffer between them and their local customers. The “customer” was unwilling to collaborate and cooperate in way that would be necessary to design and implement CRM systems. There was no indication that CRM was worth implementing beyond very specific incentives of financial nature (which were of questionable legality in the MNC’s home country) and accommodations in business agreements that the MNCs found detrimental to their business goals.

The socialist mindset prevented automatic consideration of customer segmentation based on profitability. Without market oriented mission /vision identified, non-financial goals that could serve as objective criteria for segmentation were absent. As a result, the SMEs saw CRM implementation as primarily the acquisition of CRM software (foreign providers at first, with local providers soon bringing knock-offs to the market at lower prices), and rapid deployment in the sales management system. To the extent possible (handicapped by lack of basic infrastructure) key users of the software were provided with condensed training and sent into the field. The CRM system in most cases was an add-on to the prevailing operations and played a supplementary

rather than primary roles. Adoption was half-hearted among the key users, and non-existent among the rank and file personnel of the organizations. The critical fourth and fifth stages of the western implementation model was totally ignored. Very little effort was spent in validating the success of pilot implementations, and almost none to make structural changes in the organization that were seen as extremely important in the western model. The hyperactive growth in the technology sector with its promise of a panacea for all business problems prevented the companies from asking the tough questions about the payoff of investments in CRM technology.

The scenario underwent a significant change with the bursting of the technology bubble. The move to implement CRM continued, but the pace became less frenzied and issues of accountability, responsibility and pay-back on investments became legitimate. The issue of CRM implementation is more likely to be considered as a carefully evaluated investment rather than a statement of “market orientation in the post WTO era.”

It can be concluded that after the initial frenzy of indiscriminate headlong plunge into a scarcely understood and untested technology has passed. The Chinese market is in the process of taking a second crack at CRM implementation, but this time taking a more critical approach that seeks to proceed more cautiously, and adapt a strategy that suits the domestic conditions.

### **3. Barriers to CRM Implementation in China**

The managerial mindset possibly creates the biggest obstacle for successful CRM implementation in China. Sampson Lee [2] identifies the following as primary: restricted view of CRM as only software, difficulty to understand CRM scope and goals, affordability of implementation, poor ROI, lack of assigned responsibility and designated authority. While the present author broadly agrees with the above characterization, this picture is simplistic.

One of the main reasons for loose CRM implementation is the Chinese market itself. With China being unique among the countries of the world that can sustain reasonable growth rate through domestic market development alone, the emphasis on retention of customers is not as critical as it is in the more developed countries that it is trying to emulate. Fueled by a steady supply of new qualified entrants into the market, the CRM systems are not under the gun as they are elsewhere. So the standards for evaluation and measurement of performance are not as stringent.

Another constraint is the lack of customer information. While systems for gathering and use of customer data are bundled into most CRM software now in the market, the culture still is not comfortable with the idea of sharing information. The Chinese art of “Guanxi” focuses on the nurturing and development of personal relationships that cement the alliances in informal social networks and significantly affect the underpinnings of formal and quasi-formal business and institutional relationships in

Chinese society. However, the focus of “Guanxi” is more on the exchange of favors than on the characteristics of the actors or the scope and structure of the relationship between them. Business partners, as well as consumers are not willing, in general, to share information about each other and their operations. In addition, the information available about the environment of business and available infrastructure is spotty at best in coverage, and have been shown to have questionable validity. Any strategic planning and customer segmentation based on the above sources are not likely to be very useful.

Lack of ability and willingness to adapt western knowledge of successful CRM implementation to the Chinese context has been another obstacle. The particular cultural and macro-economic characteristics of the Chinese environment that interact with the CRM implementation strategy needs to be studied by academics and practitioners in order to develop guidelines for adaptation. Without that, the frustration level is difficult to survive.

Finally, the need to develop a more realistic expectation when it comes to outcomes of CRM implementation will also be necessary for the concept to become acceptable to mainstream organizations. The absence of expectations grounded in reality and objective evaluation mechanism to document successful CRM implementations.

So in summary, a culture that does not support extensive gathering of detailed information on transaction partners, difficulty in making necessary adaptations for Chinese environment, and lack of realistic expectations and benchmarks for measuring outcomes are the primary obstacles to CRM implementation in China.

#### **4. Results of Exploratory Study**

A exploratory study was conducted to examine the state of CRM implementation in P.R. China. The method employed was to first identify news articles in English language Chinese media. China Daily (Beijing Edition), and Business Weekly (A China Daily publication) were the primary sources. Internet based archives were used for the former, and print archives of the latter were used. The period selected for the search was January 1, 2002 to July 31, 2002. The choice was arbitrary. The period was after China was admitted to the WTO in December 2001. A total of 137 news items were uncovered that had at least 800 words of content. The results of the content analysis are provided below. There is no claim made to any statistical validity of the results, as they are from a convenience sample. However, they provide a basis on which to design future studies for more valid inferences. The articles are journalistic pieces based on interviews conducted by the reporters with principals of the companies. It is assumed that the reporters have not taken

editorial liberties.

#### **4.1 View of CRM**

The sample of selected articles were scored for their references to components in a definition of CRM: A systematic approach(12%) to the use of strategically (37%) defined business processes(15%) that incorporate technology (94%) to enhance the scope and quality of acquiring(23%), servicing(16%) and retaining(3%) customers. The percentages in parenthesis refer to the proportion of cases that made a direct or indirect reference to these concepts. It is obvious that the overwhelming majority see CRM as a technology implementation, and only a minority are recognizing the broader aspects.

#### **4.2 CRM into Organization**

Upon content analysis, the articles indicated that CRM implementation had the following penetration when it came to organizational integration and involvement: Strategy (64%), Customer Segmentation for Differential Service (42%), Technology Acquisition and Deployment (94%), Process integration( 8%) and Organization Restructuring (6%). The data again appear to be in line with a rather superficial approach to CRM implementation by domestic Chinese SMEs.

#### **4.3 Evaluation Criteria for CRM Success**

The objectives (and hence criteria for evaluating success/failure) of CRM implementation according to the sample were Customer Loyalty (86%), Prospecting Success (71%), Customer Retention (36%) and there was no mention of Cross-Sell/Up-sell (0%). These results seem to show that Chinese SMEs are only scratching the surface when it comes to the scope of CRM benefits, but they expect a high level of sales success to be a part of the resulting benefits.

#### **5. Conclusions and Implications**

This exploratory study documents the early stage of CRM implementation in market in transition that has the potential to shortly become the most lucrative in global context. The results suggest, however, the need for careful study of the constraints in the Chinese context and indicate planned changes in business culture and management thinking to achieve more consistent results.

#### **References**

- [1] CRM in China, [www.greaterchinacrm.org/contentid=475](http://www.greaterchinacrm.org/contentid=475)
- [2] Chinese CRM, [www.greaterchinacrm.org/contentid=475](http://www.greaterchinacrm.org/contentid=475)

# A Holistic Approach for E-Business Engineering

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## Abstract

In the recent years, the broader application of web-based technologies caused radical changes and a consequent rapid development within the entrepreneurial environment. In order to exploit first-mover advantages, enterprises often preferred a quick-paced introduction of E-Business solutions, hence neglecting more holistic and integrated approaches. This fact implied that E-Business solutions were usually simply and hastily embedded into the existing business processes and organizational structures. As a result, E-Business projects often did not reach the striven targets or even failed, with the consequently growing lack of trust towards the above-mentioned business approach. Hence, there is a clear need for action in the field of methodical development, deployment and integration of E-Business solutions into the entrepreneurial structure. We present an integrated framework for the engineering of E-Business, which is the result of a 3 year experience at FIR.

## 1. Background

During the past years, the fast development of new Information and Communication Technologies (ICTs) has been revolutionizing the market arena and it extended the horizon of competition [16]. Such development has been causing radical changes in all business branches [1] [2] [15] [16] [19] [22] [31] [33] [35] [39] [41] [43]. New ICTs and the related new business approaches allow enterprises to design leaner intra-organizational processes, with the result of enhancing efficiency and productivity [28] [32] [38] [40]. Besides that, ICTs can strongly influence inter-organizational processes, by supporting co-operation within entrepreneurial networks as well as by enabling their co-ordination – by means of Internet-based Business Collaboration Infrastructures (BCIs), such as Electronic Marketplaces, Exchange and Communication Platforms or Supply Chain Integrators [18] [21] [39]. Hence, web-based ICT solutions play a crucial enabling role both for new business models and for those models that, up until now, had a higher value on a theoretical than on a practical level (e.g. Virtual Organizations) [13] [31]. Anyhow, a lot of open issues and unsolved problems are still to be faced. As a matter of fact, the selection and matching of organizational approaches and suitable E-Business solutions, as well as their appropriate engineering, is a complex problem. During the past years, it often happened that E-Business solutions

were simply and hastily embedded into the existing business processes and organizational structures. As a result, E-Business projects often did not reach the striven targets or even failed, with the consequently growing lack of trust towards ICTs and the related solutions. Because of our experience with reorganization projects, we are convinced that, instead of a partial one, a holistic approach has to be followed. Hence, it is important to abstract from all methods and working procedures in use, in order to be able to build up a holistic “integration framework”. Such an approach will enable us to identify and manage causal relationships between the strategic planning, the engineering of new organizational structures and the related controlling. Furthermore, new ICT-based organizational frameworks and E-Business solutions do not have to be only appropriately developed and integrated into the existing organization, but have to be also operated, managed and maintained (operations management). This requires a methodically founded tool. Hence, in order to face all above-mentioned issues, we developed a framework, which we use to systematically develop, implement and integrate E-Business solutions in manufacturing enterprises. We will present it in the next section (section 2). Hence, we will discuss a research work that we conducted with the support of our integration framework (section 3). Thus, we will present a case study to test the concept (section 4). Eventually, we will draw a set of conclusive considerations (section 5).

## 2. The FIR Integration Framework for E-Business Engineering

### 2.1 The Research Institute for Operations Management (FIR)

The Research Institute for Operations Management (Forschungsinstitut für Rationalisierung, FIR) is an independent research service provider at Aachen University of Technology (RWTH Aachen), with a 50 year experience in developing and applying methods for the enhancement of economic and industrial growth. The FIR is a registered research association and it has about 150 member companies and associations. The FIR has 4 research departments (E-Business Engineering, Logistics, Production Management, and Service Organization) and several interdepartmental practices, in which 70 permanent employees and further 70 academic and student assistants design the operations management in the company of the future.

In accordance with the public assignment, the methods and tools that are designed in cooperation with partners within and outside of the FIR research association are made available in particular to SMEs. As mediator between practice and theory, the FIR follows the idea of an application-oriented research, and promotes the enterprises' active participation within this process. We adapt our research results to specific lines of business and specific companies, and promote their transfer into the targeted branches.

As a research service provider the FIR acts as a “lobbyist” for the companies in pre-competition research, as a partner of trade and industry and as a research institution for national and international associative projects. These public funded projects are promoted by the European Union as well as by the German Federal Ministry Economics and Technology, and the German Federal Ministry of Education and Research. Furthermore, with the help of projects for industrial and service customers, the FIR deepens its research work within a commissioned research framework. The institute cooperates with consulting institutions, which fulfill important transfer functions within the innovation and research process. Last but not least, the FIR supports its projects through various partnerships with national, European, American, and Asian research and transfer institutions.

## 2.2 E-Business Engineering at FIR

Currently, there are different and not always concordant definitions of the term E-Business, e.g. in [1] [41] or [43]. E-Business will be here defined as the “holistic ICT-based support of (dynamic) inter-organizational and intra-organizational processes and transactions” [13]. E-Business hence implies the modification of existing business relationships and might thus lead to the development of new or modified business models. Within this context, we define E-Business Engineering as all the methods and procedures that support companies of different industrial sectors to systematically develop, implement and run E-Business solutions. E-Business Engineering can be hence defined as the systematic design and implementation of E-Business solutions and models.

Within our field experience and our daily interaction with German and European SMEs, we realized that enterprises lack of appropriate and structured methods deploy E-Business in their organizations. As a matter of fact, the decision related to the adoption of E-Business solutions as well as their embedding into an organization is a complex problem which had been too often underestimated in the recent past. Because of our experience with reorganization projects, we are convinced that, instead of a partial one, a holistic approach has to be followed. Hence, it is important to abstract from all methods and working procedures in use, in order to be able to build up a holistic framework. Such an approach can enable decision-makers to identify and manage causal relationships between the strategic planning, the

engineering of new organizational structures and the related controlling. Furthermore, new ICT-based organizational frameworks and E-Business solutions do not have to be only appropriate developed and integrated into the existing organization, but have to be also operated, managed and maintained. Clearly, also the operations management under the new ICT-driven constellation requires a suitable and methodically founded support.

In order to deal with all above-mentioned issues, we developed a framework, the FIR Integration Framework for E-Business Engineering, which we use to develop, implement and integrate E-Business solutions in enterprises. The approach exploits several established methods from the fields of product and service engineering, business organization and computer science (e.g. methods of business modeling, service engineering, product design, process and system design, monitoring and planning of technology). The basic idea behind this approach is that we intended to adapt and integrate such established modeling, design or engineering methods, in order to fulfill the new modeling and organizational requirements triggered by the potentials of new ICTs and of the related solutions. This approach supports also to the development of new and innovative methods. The four layers of the framework are the most relevant design areas (business models, products and services, business processes, and IT) that, according to our understanding, guarantee a complete analysis of enterprises and help to define the appropriate structure for the development and embedding of E-Business solution in organizations (see Figure 1).

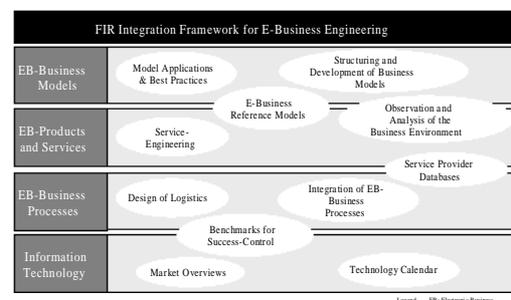


Figure 1 – FIR Integration Framework

All the different partial methods as well as their interactions represent the core elements of the integration framework, which is structured into the following layers:

1. E-Business business models. This first layer deals with the design and development of E-Business architectures that strive the achievement of more efficient inter-organizational relationships, e.g. within the exchange of products and services within manufacturing networks. The design of new business models in a networked economy as well as the definition and assessment of E-Business scenarios are also major issues. Furthermore, the design has to be done by taking into specific consideration the achievement of sustainable turnovers and profits.
2. E-Business products and services. On this layer the focus is on the systematic development of innovative

E-Business products and service portfolios, both for manufacturers and for service providers.

3. E-Business business processes. This layer concerns the analysis of the organizational and entrepreneurial changes triggered by E-Business, especially regarding inter-organizational as well as intra-organizational activities and processes that are heavily supported by electronic Information and Communication Technologies. The target is here the support of the business activities, especially inter-organizational, with integrated and efficient ICT-solutions.

4. Information and Communication Technologies. As a matter of fact, ICTs are the basis for all E-Business activities. A thorough analysis of existing and future ICTs, as well as methods of technology management and planning are the basic requirement for the efficient and targeted use of ICTs. Furthermore, the identification of application potentials of innovative ICTs as well as the attempt to integrate isolated E-Business solutions is a critical success factor.

The Integration Framework for E-Business Engineering has been really useful for the work of the E-Business Engineering Department at FIR. As a matter of fact, the framework is shared by the whole department and it hence represents a starting point and a reference for the structuring and solving of problems in our industrial projects. In fact, such an integrated model proved to be really helpful within the development of new methods of higher complexity. In the next section we will present a meta-method to develop electronic Business Collaboration Infrastructures for networked organizations that we developed using the Integration Framework for E-Business Engineering.

### 3. The Design of New Intermediaries: a Path from Business Modeling to Technology Management

As previously stated, web-based ICT solutions play a crucial enabling role both for new Business Models and for those models that, up until now, had a higher value on a theoretical than on a practical level (e.g. Virtual Organizations) [13] [31]. As a matter of fact, recent trends show that companies, in order to face the quick-paced globalization process, tend to concentrate on their own core competencies, before starting to co-operate within global networks of enterprises [16] [22] [27] [29]. This transformation process is crucial for the success of the company's business [31]. Therefore, before making a strategic decision regarding the participation to a co-operation network, the management of an enterprise has to take into consideration a wide set of aspects, such as the entrepreneurial organization, the own core competencies, the needs of the customers, the readiness of the potential partners to co-operate, and the availability of the needed technologies and tools [5] [13] [16] [33] [41].

In particular, enterprises have to weigh a set of crucial success factors in the fields of standardization and information technology management [15] [23]. For

instance, on the one side communication standards are essential to achieve an efficient exchange of information and data [3]. On the other side, branch-specific collaboration standards are crucial to establish inter-organizational workflows [19]. Furthermore, the analysis of the potentials of new technologies can help to select the most suitable technologies and tools for the support of new entrepreneurial businesses [6] [39]. A proper technology and innovation management is important to plan the development of the entrepreneurial core businesses in co-ordination with a strategic technology planning [7] [18].

As a result, in order to deploy innovative network-oriented co-operation structures, new (Internet-based) Business Models can be designed and successfully implemented [1] [34]. Amongst other aspects, the processes of intermediation and disintermediation are relevant phenomena in this context [21] [37] [38] [39].

Within this section we will present a new business modeling approach for a networked economy and hence focus on the design of information models in a networked economy (section 3.1 to 3.3). In order to identify the needed ICTs for a new E-Business Model, we will eventually outline a methodology for technology planning (section 3.4).

#### 3.1 The Internet and the New Business Models

In the management literature there are different and discrepant definitions of the concept of Business Model [1] [41][43]. Furthermore, (E)-Business Models can be classified according to the most different criteria, such as the degree of innovation and functional integration, the collaboration focus or the involved actors [35] [41] [43]. The core objective of each company is a long-term creation of added value [33]. The entrepreneurial strategy defines how such a target has to be fulfilled. A successful strategic positioning is achieved through a sustained profitability, an own value proposition, a distinctive value chain, an entrepreneurial fit, and continuity of strategic direction [33]. According to our understanding, a Business Model is an instantiation of an entrepreneurial strategy related to a specific business and it encompasses six different sub-models (see Figure 2): (1) Market model: definition of the market(s) of action (targeted customers as well as potential competitors); (2) Output model: definition of the output requirements and design of the outputs (products or services); (3) Revenue model: estimation and calculation of the expected revenues; (4) Production design: design of how the performances have to be deployed; (5) Network and information model: partner selection and configuration of the network, as well as configuration and management of the (distributed) information; and (6) Financing model: scenario-based definition of risks and expected profits to search for investors or to persuade the stock holders [12].

In the new ICT era, companies strive to exploit the advantages of the networked economy. Lately, Business Models tend to involve different enterprises with the goal of bringing higher profits to each of the participants [1]

[31]. The modeling of such co-operative E-Business Models represents a significant challenge, since there are no appropriate methods to tackle systematically such modeling issue. We developed a customer-oriented business modeling approach for intermediaries within dispersed manufacturing networks.

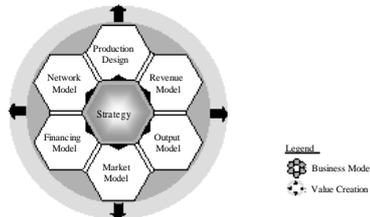


Figure 2 - Strategy, Business Model and Added Value

### 3.2 The House of Value Creation

Due to the globalization, the growing transparency of the markets and the resulting increased competition, enterprises have to focus more and more on their customers. As a matter of fact, the fulfillment of the customers' needs is an essential precondition to generate turnover. This means that enterprises have to take this aspect into deep consideration and must consequently shape Business Models that reflect the customers' needs [14]. Because of the above-mentioned reasons (see section 3.1), until now the development and adjustment of Business Models has been performed by companies mostly in a creative way. As a matter of fact, in the state-of-the-art there is hardly any holistic methodical support. A successful approach to tackle this methodical lack must be based on a strategic focus on the customer's needs. Within a running research project, we developed the House of Value Creation (HVC), a method to design customer-oriented and sustainable Business Models (see Figure 3) [12][26]. The HVC is a meta-method, since it consists of three logical pillars (input, method, and output) and of six process layers (each of the process steps requires a suitable method). The method suits explicitly the design of Internet-based Business Collaboration Infrastructures [14].

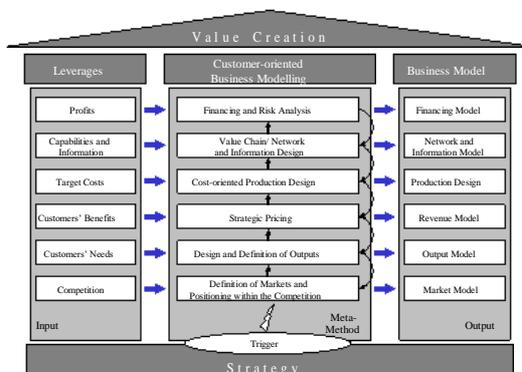


Figure 3 - The House of Value Creation

Because of our understanding of the term Business Model and because of the fact that the ultimate goal of a company is long-term value creation, the design of a

Business Model has to be definitely based upon the entrepreneurial strategy. Therefore, if not already done, the first step within a business modeling process is to define the rough entrepreneurial strategy, on which the Business Model will be based [25]. The meta-method of the House of Value Creation illustrates the correlation between a set of significant leverages (first pillar of the HVC), the Customer-oriented Business Modeling process (second pillar), and the resulting Business Model (third pillar).

As previously hinted, our Business Modeling approach encompasses six layers that correspond to six following steps of the method. The first HVC phase is triggered either by the inside or by the outside of the company – through a new idea, invention, innovation or modifications of the economical environment. The six steps of the method are [26]:

1. Definition of the markets and positioning within the competition. The initial decision regards the category of products or services to deal with (as well as the substitutes). Hence, a consequent monitoring of all strong players (suppliers, customers, and possible competitors) has to be done. This phase deals with the branch profitability and with the rivalry among existing and potential competitors. Phase output: market model, with a clear identification of the key players, customers and competitors.
2. Definition and design of the outputs. In the product design, a well-proven method is the Quality Function Deployment (QFD) [17] [30] [42]. With this approach, a customer-oriented product development can be successfully realized. Therefore, after defining markets and identifying core customers and competitors, the outputs (physical products or services) have to be shaped in order to maximize the customers' benefit according to a QFD-like method. Phase output: output model, with a detailed customer-oriented design of the outputs.
3. Strategic pricing. The identification of prices for the planned outputs should be more the result of a strategic positioning than of a cost-oriented approach [14] [16]. The price calculation should take into consideration the customers' surplus constraint as well as the strength of the competition (existing barriers of entry, such as patents, industry property rights, etc.) [20]. Phase output: revenue model, with a detailed description of how earnings will be achieved.
4. Cost-oriented production design. According to the guidelines of the revenue model, the target costs for the output model will be calculated (as the upper bound for direct costs). Hence, the requirements to the value chain will be detailed. Phase output: production design, with a detailed description of how the performances have to be achieved.
5. Partners, network and information. In this phase, starting from the requirements on performances of the value chain, the capabilities (core competencies, capacities, available modules and components, ICT infrastructure) of the own performance structure and of the potential partners will be thoroughly scanned. Phase

output: network model, selection of the partners within a specific instantiation of the value chain and network configuration, as well as information model, i.e. the approach according to which the information management issue has to be tackled.

6. Financing and risk analysis. Eventually, based upon the expected profits and a suitable scenario analysis, the risk-level as well as the need for working capital must be calculated to start the search for investors [11]. Phase output: financing model.

At each step of the HVC the corresponding targets must be fulfilled. If one step is not fulfilled, then the process should go back to a prior phase as long as the issue is tackled – with an iterative approach.

In the following section, our contribution will focus on a specific level of our HVC, namely the one regarding network and information model. A specific attention will be paid to the necessity to manage information, information flows and ICTs within distributed manufacturing networks and to the approach with which such goal set can be achieved.

### 3.3 The Design of Information Models in a Networked Economy

In the 5<sup>th</sup> phase of the HVC customer-oriented Business Modeling, starting from the requirements on performances of the value chain, the state-of-the-art and the capabilities of the own performance, information structures and ICTs, as well as of the ones of the potential partners, will be thoroughly scanned. The striven value chain will be designed and a specific network will be instantiated.

As stated in section 3.1, before making a strategic decision regarding the creation of a co-operation network, the management of an enterprise has to take into consideration a wide set of aspects, such as the entrepreneurial organization, the own core competencies and the ones of the partners, and the available technology. The gathering of all information regarding the potential network participants represents what we define as capabilities and information. According to the requirements previously identified within the production design (output of phase 4 of the HVC), a crosscheck with the capabilities of all potential partners helps to define the set of suitable partners. This process can be supported e.g. by the use of specific intermediaries such as vertical E-Marketplaces. The data about the entrepreneurial capabilities must regard both the own performances, the ICT capabilities as well as the maturity of the involved technologies [23] [31]. As a result, the instantiation of a specific network configuration can be identified. Furthermore, the definition of inter-organizational blue prints and branch-specific process standards is necessary to enable lean and efficient inter-organizational processes and workflows. The result is the network model (see Figure 4) [25]. The most relevant aspect for the following phase is that the inter-organizational processes determine the sources and the sinks of distributed information. The information design focuses on the management of the

information within such entrepreneurial networks and inter-organizational value chains (see Figure 4).

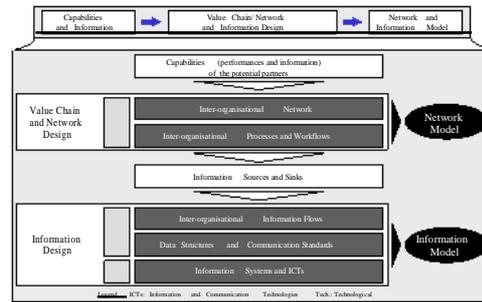


Figure 4 –Design of Network and Information Models

Within the modeling of an inter-organizational information management model, we distinguish three different layers [24]:

1. Inter-organizational Information Flows. Starting from the sources and the sinks of distributed information, the inter-organizational information flows can be derived and consequently defined. Within this process, several different aspects have to be taken into consideration: direction (e.g. one way or bi-directional information flow), involved actors (broker, network members, and related intelligent agents), involved systems (e.g. knowledge management, distributed Data Base information sources), and relationship (e.g. 1:1, 1:n, m:n). Furthermore, information flows encompass two other major dimensions: information width, which sets the different degrees of information broadcasting and transparency within the network, and information depth, which defines the scope, aggregation level and content of the information flow.

2. Inter-organizational Data Structures, Communication Standards. A crucial issue is the development of an inter-organizational data model to ensure the consistency, quality and transparency of the data. A data model encompasses also the aggregation levels for Management Support Systems (e.g. Data Warehousing and Data Mining). Furthermore, the branch-specific development of shared communication standards (e.g. based on XML) is essential to achieve and ensure a fast exchange of information and data through inter-organizational networks, as well as the integration of different ERP systems within an Internet-based BCI. The identification of the most appropriate technology standards is also important to deploy a back-end integration in each of the involved enterprises. Eventually, an appropriate solution for the security issue has to be identified.

3. Information Systems and ICTs. Enterprises have to weigh a set of crucial success factors in the field of technology management. The analysis of the potentials of new technologies as well as their diffusion and maturity can help enterprises to select the most suitable technologies to face challenges in the context of new collaborative businesses. For instance, the technical support of information flows in relation of complexity of the considered job and of the media richness (regarding e.g. real-time or asynchronous response) can be done according to the Media Richness Theory [8]. As a matter

of fact, a proper technology and innovation management is important to plan the development of the entrepreneurial core businesses in co-ordination with a strategic technology planning [6] [7] [23]. Last but not least, a make or buy decision has to be taken, e.g. between the exploitation of the services of an Application Service Provider and the development of an own platform.

Within the definition of Information Systems and ICTs, one of the most crucial issues is the identification of the most appropriate ICTs out of the set of all suitable technologies that might suit to the striven target [2] [6] [7] [8] [15] [23] [28] [32] [40]. Because of the dynamic technology development, the temporal horizon has to be considered in detail within the network and information modeling phase. As a matter of fact, the development of innovative ICT-based solutions requires an appropriate consideration of both available and future technology potentials. Furthermore, the future technology potentials usually imply an impact on the network organizational structure. This means that interdependencies between the network model and the information model have to be taken into consideration, when carrying out a middle or long term analysis. In order to meet this peculiar challenge, in the next section we outline a new planning methodology that incorporates the interdependencies between network structure and processes on the one hand and ICTs on the other hand.

### 3.4 Planning and Management of Technology

In order to fully benefit from the advantages of the inter-organizational co-operation, the network needs a sustainable support of Information Systems and ICTs. As pointed out above, the adequate identification, selection and management of suitable Information Systems and ICTs is a great challenge. In fact, there might be many different, often even partly competing network partners, whose different needs (also over the time) must be considered when selecting and assessing ICTs and electronic services to support the network [2] [6] [15] [37] [39]. Within our research, we observed that various ICTs are capable to support the different inter-organizational processes and workflows [4]. In order to guarantee smooth inter-organizational processes, the selected ICTs must therefore be integrated seamlessly. Furthermore, the high pace of technical development requires a planning process that considers both currently available and also future ICT-solutions [6] [7] [23] [40]. Finally, the potentials of future ICTs might influence the network structure, so that the business relations between participating companies may also change over the time [15] [37] [38] [39]. Therefore, potential impacts on the network must be considered and evaluated when selecting and assessing specific Information Systems and ICTs as network infrastructure. This is what we define as Integrated Planning and Management of Networks and of Information Technology [4]. Figure 5 shows how the temporal interdependencies of network structure and processes and ICTs should be integrated into the planning process. This enables the decision-makers to assess the

mutual influences and hence to deploy appropriate measures. We will now present an approach with which such an result can be achieved.

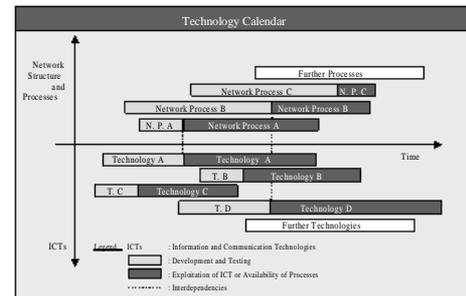


Figure 5 – Integrated Planning of Network and ICTs

First of all, because of the complexity related to this planning task, a suitable description model is fundamental for a successful planning. As a matter of fact, such a model must describe all characteristics of potential networks, the different parameters of ICTs as well as the complex links between these two clusters. As previously stated, this approach has to enable the full and sustainable exploitation of technologies over the time and herewith the implementation of new and unique network structures.

For this reason we developed an integrated description model to identify and highlight the interdependencies between different network instantiations and the underlying technologies (see also [9]). Our model (see Figure 6) fulfils the above-mentioned requirements.

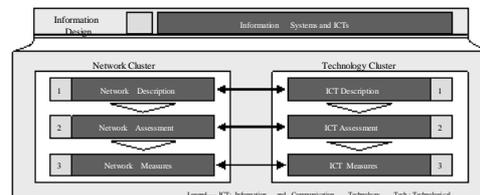


Figure 6 –Description Model for Integrated Planning

The description model consists of three layers for each of the two clusters. These layers correspond to three different steps within the planning and management process. The first layer is a crucial step within the model and it aims at the description of networks and ICTs as well as their matching. In Figure 6, the matching is represented by the arrows. In the second layer all relevant factors for the assessment of the feasibility as well as the sustainable cost-effectiveness are collected and compared. Eventually, in the third layer the necessary measures to deploy a specific network as well as to develop and exploit the appropriate ICT-infrastructure are derived. Within the last two steps a particular attention is paid to temporal constraints, as illustrated in Figure 5.

As mentioned above, the description and matching of the network and ICTs in the first layer is a complex task, because of the existence of several interdependencies between the two clusters. In order to enable an easier matching it is helpful to distinguish between network processes and organizational potentials on the one side as well as ICT functionalities and ICT potentials on the other

side (see Figure 7).

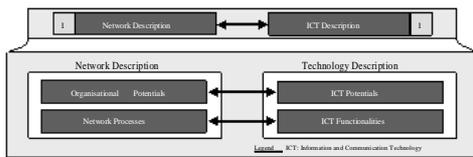


Figure 7 – First Layer of the Description Model

According to our understanding the organizational potentials represent the capability to develop and implement innovative organizational concepts (in this specific case regarding the network structure). Clearly this requires a creative process that has to take into consideration the potentials of existing and planned ICTs. Examples for organizational potentials are for instance the ability to work in distributed environments without suffering the disadvantages caused by the lack of e.g. face-to-face communication. Furthermore, examples of ICT potentials are the overcoming of temporal and spatial barriers through the use of the web-based technologies.

The network processes are the specific instantiation of the inter-organizational processes and workflows, as we previously defined within the value chain and network design of the network model (see Figure 4). These processes need to be supported by ICTs. The ICTs can be further described by their functionalities, which specify which task the particular technology can perform. According to our understanding, the functions have to be elementary, this meaning that each technology can be associated with exactly one function (see also [36]). As a matter of fact, we identified four clusters of elementary functions, and namely :

1. Input and Output functions. These functions, often also called User Interface, include especially audio and video technologies. The decision about the input and output technology that is the most appropriate to support the network partners and customers depends heavily on the information that needs to be presented.
2. Processing functions. Processing technologies allow the modification and analysis of input data to generate the needed information. The necessary processing capacity for a certain task is a relevant criterion in this context, and operating systems and programming languages must also be taken into account.
3. Transmission functions. Since the co-operating enterprises are often widely distributed, communication technologies and standards are needed to transmit information between technical devices and/or network partners.
4. Storage functions. Clearly, before and after any handling and modification of information, the corresponding data must be stored.

Although all these functionalities are not completely independent, hardware and software technologies can be identified in each cluster; hence, each cluster can be to some extent dealt with separately. The functions are described in detail by a set of parameters. Furthermore, the parameter set depends on the particular function and technology. Storage technologies, for instance, are

characterized by capacity and access time, while transmission technologies are classified according to e.g. bandwidth, bit error rate and jitter.

After the network processes have been defined, each specific network process step has to be matched with all suitable technologies that might support it. For example, the requirements related to the exchange of information and data between different network partners need to be matched with all available technologies that enable transmission functions, e.g. transmission protocols, standards or light-wave cables. As a result, the technology or set of technologies with the most suitable parameters is selected.

According to our understanding, the above-mentioned method is a successful approach to deal with the challenge to match value chain and network design with the management of technology within the information design process. In the next section we will show, with the help of a case study, how the potentials of our method can be exploited.

#### 4. The Development of an E-Business Collaboration Infrastructure

Each industrial sector has its own peculiarities; therefore, it is necessary to develop approaches and solutions that take into account such specific requirements. Our institution has experience with German SMEs of the manufacturing and machinery industry. Since we identified a remarkable need for “e-action” in this traditional and static industrial branch, we therefore decided to develop customized Business Models and E-Business solutions with a high impact onto this industrial sector. In this context we developed the case study for the present contribution. The case study has been conducted in the field of manufacturing networks for metallic material with 10 German SMEs. As a matter of fact, the generation and mailing of so-called paper-based test reports for metallic material, which documents and guarantees to the buyer specific material properties, is nowadays accompanied by several serious problems. For instance, the open issues concern the archiving of reports, the specification check of corresponding material standards or norms referenced in a test report [10]. The innovative trigger for this case study is the worldwide dissemination and acceptance of the Internet as communication and information exchange channel as well as the idea to exchange material test reports electronically. This makes the development of new intermediary services for the efficient exchange and storage of material test reports based on an electronic Business Collaboration Infrastructure feasible. Based upon the innovative idea of exchanging electronic material reports on a collaborative Internet-platform, we proposed a Business Model for an information service intermediary. We are now going to present the results obtained within the business modeling process.

1. Market model. After a thorough market analysis we identified similar solutions to manage and exchange

material reports (e.g. Document Management Systems, DMS), but we realized that none of them fulfils all relevant requirements. Hence, in the resulting market model there are no direct competitors because of the fact that the planned service is innovative and therefore it is not offered in the market yet. Furthermore, the potential customers are all the manufacturing enterprises that exchange metallic products – i.e. both ferrous metals (all sorts of steel) and non-ferrous metals (such as tin, copper, and brass) - with specified and guaranteed properties, as well the different testing and inspection organizations (such as TÜV or Dekra in Germany, Det Norske Veritas in Norway, BSI or ITS in Great Britain, SGS in Switzerland, Bureau Veritas in France)

2. Output model. We conducted several workshops with the involved SMEs and thus we gathered all the requirements related to the exchange of electronic material test reports in the manufacturing field. We distinguish two kinds of groups of services required by the potential customers of the platform:

- a) Basic service, e.g. storage, access, and remote archiving of electronic material test reports over the Internet.
- b) Value-added services, e.g. assessment and evaluation of the suppliers, nominal/actual value comparison of measures certified in a test report, batch management, offering of detailed information about material-related quality.

Other general requirements on the overall performances of the platform are: a high operating efficiency and flexibility, specific security requirements (e.g. transmission and privacy), a 24x7 hours system availability, a suitable multi user concept with different and adjustable levels of authorizations, support of surveyors of independent testing and inspection organizations.

3. Revenue model. After an analysis of the customers' benefit, we used a two-step price corridor method for the strategic pricing for shaping a revenue model [14]:

a) Identification of the price corridor of the mass, i.e. search for the price corridor that the majority of the customers is willing to bear. According to the market model, there are no direct competitors, but only some possible substitutes, i.e. providers of DMS, whose products, though, do not fulfill all relevant customers' requirements. We observed that the innovative services of the planned intermediary service infrastructure might therefore crucially change the power balance in the market of tools for the management and exchange of material test reports. The current cost to process a single material report amounts up to about 50 US\$, which clearly represents an upper bound for the price model. Since the process cost for an electronic test report drops drastically by the use of the intermediary service infrastructure, the decision was to pursue a low price corridor strategy to target a high number of customers.

b) Specification of a level within the price corridor, i.e. identification of an appropriate price level within the chosen low price corridor. A detailed analysis of the

customers' benefit of the DMS underlined that none of them can fulfill all industrial requirements. Therefore, the intermediary service infrastructure with its innovative customer-oriented services has realistic chances to be widely accepted by the target group and thus to penetrate successfully the market. In order to conquer the market and achieve the striven critical mass in terms of traffic (reports/period of time), it was furthermore decided to choose a lower pricing-level within the chosen low price corridor. A high traffic, though, does not yet guarantee a long-term success, because second-movers might come up with similar solutions and gain quickly market share. Hence, the price should be maintained very low until the critical mass in terms of branch members is also reached. With the achievement of this goal, the developed format for electronic test reports will be widely disseminated and it has therefore good chances to be accepted and adopted as a branch-specific standard. At this stage, barriers for market entry for possible competitors will be significant. The deployment of a mid or upper-level pricing within the selected price corridor will be then possible without risking to loose market shares. A potential cash cow for the business is represented by the portfolio of attractive value-added services.

4. Production design. According to the guidelines of the revenue model, the target costs for the output model will be calculated within the cost-oriented production design, i.e. design of the electronic transmission, management and storage of material reports. In the case of the "production" design for the transmission of material reports, the attention was paid to the fixed costs (i.e. target costs for the infrastructure) since direct costs (i.e. cost for the report transmission) tend to zero. Hence, the result is a platform with a targeted low fixed cost (e.g. hardware, software and mainly personnel costs). The lower the fixed costs are, the sooner the critical mass in terms of participants and transactions will be reached.

As far as concerns the design of the platform, we identified the need for the following capabilities: database based material test reports management and archiving, material science know how, trust management, and information content for value-added services.

5. Network and information model. In this phase, starting from the requirements on performances and from the capabilities, core competencies and IT infrastructure of the involved potential partners, a specific performance network as well as an information and technology framework were defined. The targeted market consists of several SMEs, of which none of them is dominating the market. It is important that all enterprises that take part to the platform must trust and be able to rely on the carrier. Hence, the managing institution of the transaction platform for electronic test reports must be an independent company. It was thus decided that the collaboration platform should not be managed by one of the manufacturers of metallic material, but by a neutral intermediary with material science know-how as well as ICT competence (e.g. data base management and archiving). As a matter of fact, the archive management

and value-added services that require particular material science know-how will be performed by the intermediary, who will outsource the other competencies to two different partners; one partner was identified to deal with trust management and another to provide information content for the other value-added services. Within the analysis of the information infrastructure, the crucial issue was the modeling of processes and the management of shared information to enable the inter-organizational and intra-organizational workflow capabilities of the planned ICT-System. Furthermore, some of the other most interesting aspects that were dealt with are the definition of process standards for inter-organizational processes and workflows, the development of an appropriate and flexible interface to deploy a back-end integration in each of the involved enterprises, and the branch-specific development of a shared standard for electronic test reports. Such standards ensure a fast exchange of the required information through inter-organizational networks as well as the integration of different ERP systems.

Last but not least, as far as the ICTs planning and management is concerned, an important part was the assessment and availability verification of the technologies that were previously selected to support the intermediary service processes. As mentioned in the section 3.4, suitable measures (i.e. further evaluation, acceptance and implementation, further development, or rejection) had to be derived for each of the selected technologies. Within the assessment phase, in order to cope with the different requirements and the need to identify the necessary measures for each partner, the use of a technology calendar proved to be really helpful to visualize critical temporal constraints (see Figure 8).

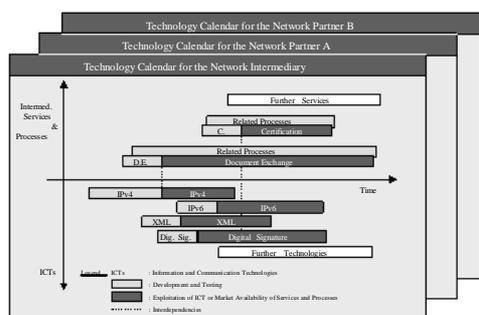


Figure 8 – Integrated Planning of Services and ICTs

6. Financing model. Because of clear privacy reasons, we are at the moment not allowed to distribute information about the financing model.

## 5. Critical Review and Conclusion

The selection and matching of organizational approaches and suitable E-Business solutions, as well as their appropriate engineering, is a complex problem. As a matter of fact, during the past years it often happened that E-Business solutions were simply and hastily embedded into the existing business processes and organizational structures. As a result, E-Business projects often did not

reach the striven targets or even failed, with the consequently growing lack of trust towards ICTs and the related solutions. In order to face successfully this issue, a holistic approach, instead of a partial one, has to be followed. In this paper we presented the FIR integration framework for E-Business Engineering, a holistic framework to systematically develop, implement and integrate E-Business solutions in enterprises. Hence, we presented the House of Value Creation, a meta-method to design customer-oriented and sustainable Business Models, which we developed with the help of our integration framework. The meta-method was validated in a specific case, namely for an information service intermediary of a collaboration network in the manufacturing industry. The HVC is also a promising approach for the development of Business Models in the case of inter-firm networks. Hence, in order to verify such a fact, we plan to test its validity also in other cases and for other branches, such as IT and logistics. As far as the project of the case study is concerned, the first step was the development of the prototypic BCI solution. Nowadays, a commercial business pilot is being deployed with the participation of all the 10 enterprises of the consortium; and the objective is to gather precious information about the feasibility of the developed Business Model as well as about the acceptance of the BCI as an efficient means to exchange material test reports. The next phase will be a commercial rollout, initially in the German market and, if the sustainability will be confirmed, on European level.

To conclude, the trend towards a tightly inter-connected economy seems to be nowadays unquestionable. On the other side, the development process towards a dynamically networked economy has just recently started. We strongly believe that, in order to be successful within a networked economy, enterprises will thus have to undergo a deep transformation process in their organizational philosophy, in their structure, in the used methods as well as in their approach to interact with external organizations. We are convinced that, in order to face the challenges of such a dynamic and insecure business context, an appropriate holistic approach is helpful to plan and hence deploy sustainable businesses.

## 6. References

- [1] Afuah, A. & Tucci, C.L. Internet Business Models and Strategies: Text and Cases. New York: McGraw-Hill/Irwin, 2001.
- [2] Bensaou, M. Interorganizational Cooperation - The Role of Information Technology: An Empirical Comparison of US and Japanese Supplier Relations. Information Systems Research, 8(1997)2, 107-124.
- [3] Bergner, K., Deifel, B., Jacobi, C., Kellerer, W., Rausch, A., Sabbah, A., et al. The Future of Information Technology - an interdisciplinary, scenario-based approach. Report of Tech. Univ. München, Institut für Informatik, Munich, 2000.
- [4] Bleck, S., Forzi, T., Laing, P., and Stich, V. The Path from Business Modeling to Technology Management. Proceedings of

- the Int. Conference Advanced Production Management Systems (APMS 2002), Sept. 8<sup>th</sup>–13<sup>th</sup>, 2002, Eindhoven (NL), 34-46.
- [5] Bleck, S., Beyer, M., & Laing, P. Methodeneinsatz bei der Erschließung des E-Business – Ergebnisse einer Studie. *Industrie Management*, (2001)1, 21-26.
- [6] Bleck, S., & Quadt, A. Planning and employment of ICTs in the field of intermediary services. *Proceedings of the 6<sup>th</sup> Int. Conference Work With Display Units (WWDU 2002)*, Berchtesgaden (D), May 22nd-25th, 2002, 500-502.
- [7] Bullinger, H. J. (Edt.), *Einführung in das Technologiemanagement*, B.G. Teubner Verlag, Stuttgart, 1994.
- [8] Daft, R., & Lengel, R. Information Richness: A New Approach to Managerial Behaviour and Organization Design. In: *Research in Organizational Behaviour*, 1984 (6), 191-233.
- [9] Davenport, T.H. *Process Innovation: Redesigning Business Processes with Information Technology*. Harvard Business School Press, Boston, 1993.
- [10] DIN (publisher) 10 204. *Metallic products – Types of inspection documents (German version)*. Beuth Verlag, 1990.
- [11] Fink A., Schlake O. & Siebe A. *Wie Sie mit Szenarien die Zukunft vorausdenken*. HBM, 2000 (2), 34-47.
- [12] Forzi, T. and Laing, P. E-Business Modeling, in Albaloooshi, F. (Ed.), *Virtual Education: Cases in Learning & Teaching Technologies*, IRM Press, Hershey (to appear in Spring 2003).
- [13] Forzi, T. & Luczak, H. E-Business: Status Quo and Perspectives. *Proceedings of the 6<sup>th</sup> Int. Conf. on Work With Display Units (WWDU 2002)*, Berchtesgaden (D), May 22<sup>nd</sup>–25<sup>th</sup>, 2002, 494-496.
- [14] Forzi, T. & Laing, P. Business Modeling for E-Collaboration Networks. *Proceedings of the 2002 Information Resources Management Association Int. Conference (IRMA 2002)*, Seattle, WA (USA), May 19th- 22nd, 2002, 961-963.
- [15] Gebauer, J. & Buxmann, P. Assessing the value of interorganizational systems to support business transactions. *32<sup>nd</sup> Hawaii Int. Conf. on Systems Sciences (HICSS-32)*, Maui, 1999.
- [16] Hagel, III J., & Singer, M. *Unbundling the Corporation*. *Harvard Business Review*, 1999, 77(2), 133-141.
- [17] Hoffmann, J. *Entwicklung eines QFD-gestützten Verfahrens zur Produktplanung und -entwicklung für kleine und mittlere Unternehmen*, Dissertation. Universität Stuttgart, 1996.
- [18] Hoeck, H., & Bleck, S. *Electronic Markets for Services*. In: *E-Work and E-Commerce (Vol. 1)*, Stanford-Smith B. & Chiozza Editors, Amsterdam, Berlin, Oxford: IOS Press, 2001, 458-464.
- [19] Holland, C.P. & Lockett, G. *Strategic Choice and Inter-Organisational Information Systems*. *Proceedings of the 27<sup>th</sup> Hawaii Int. Conf. on Systems Sciences (HICSS-27)*. IEEE Computer Society Press, Los Alamitos, 4(1994), 405-416.
- [20] Kim, C. & Mauborgne, R. *Knowing a Winning Business Idea When You See One*. *HBR*, 2000, 78(5), 129-138.
- [21] Klein, S. *Interorganisationssysteme und Unternehmensnetzwerke - Wechselwirkungen zwischen organisatorischer und informationstechnischer Entwicklung*. Univ. St. Gallen 1995.
- [22] Kornelius, L. *Inter-organisational infrastructure for competitive advantage: strategic alignment in virtual corporations*. Doctoral Thesis, Tech. Univ. Eindhoven, 1999.
- [23] Krcmar H. *Informationsmanagement*, 2<sup>nd</sup> edition. New York: Springer Verlag, 2000.
- [24] Laing, P. & Forzi, T. *Management of shared information within Manufacturing Networks*. *Proceedings of the 18<sup>th</sup> Int. Conference on CAD/DAM, Robotics and Factories of the Future (CARs&FOF'2002)*, July 3<sup>rd</sup>–5<sup>th</sup>, 2002, Porto (P), 459-466.
- [25] Laing, P. & Forzi, T. *Challenges for Business Modeling in the New Communication Era*. *Proceedings of the 31<sup>st</sup> Annual Meeting of the Western Decision Sciences Institute (WDSI 2002)*, April 2<sup>nd</sup>–5<sup>th</sup>, 2002, Las Vegas, NV (USA), 434-436.
- [26] Laing, P. & Forzi, T. *E-Business and Entrepreneurial Cooperation*. *Proceedings of the 1<sup>st</sup> Int. Conference on E-Business (ICEB 2001)*, Hong Kong, Dec. 19<sup>th</sup>–21<sup>st</sup>, 2001, 7-9.
- [27] Molina, A., Ponguta, S., Bremer, C.F., & Eversheim, W. *Framework for Global Virtual Business*. *Agility & Global Competition*, 2 (1998)3, 56-69.
- [28] Mooney, J.G. *The Productivity and Business Value Impacts of Information Technology: Economic and Organizational Analyses*. Dissertation Univ. of California Irvine, Irvine 1996.
- [29] Parolini, C. *The Value Net: A Tool for Competitive Strategy*. New York: John Wiley & Sons Ltd., 2000.
- [30] Pfeiffer T. *Qualitätsmanagement: Strategien, Methoden, Techniken*. München: Hanser Verlag, 1993.
- [31] Picot, A., Reichwald, R., & Wigand R.T. *Die grenzenlose Unternehmung*, 4<sup>th</sup> edition. Wiesbaden: Gabler Verlag, 2001.
- [32] Pietsch, T. *Bewertung von Informations- und Kommunikationssystemen. Ein vergleich betriebswirtschaftlicher Verfahren*. Erich Schmidt Verlag, Berlin 1999.
- [33] Porter, M.E. *Strategy and the Internet*. *Harvard Business Review* 2001, 79(3): 63-68.
- [34] Rayport, J. F. *The Truth about Internet Business Models*, 1999. Retrieved on September 27th, 2001, from the Web-site: [www.strategy-Business.com/briefs/99301/page1.html](http://www.strategy-Business.com/briefs/99301/page1.html).
- [35] Rentmeister, J., & Klein. *St. Geschäftsmodelle in der New Economy*. *Das Wirtschaftsstudium*, 2001, 30(3), 354-361.
- [36] Ropohl, G. *Eine Systemtheorie der Technik*. Hanser Verlag, München, 1999.
- [37] Rose, F. *The economics, concept, and design of information intermediaries; a theoretic approach*, Dissertation Univ. Frankfurt, 1998.
- [38] Ruohonen, M. *Information Technology Mediated Activities in Organizational Contexts - A Case of Strategic Information Systems Planning*. TUCS Technical Report No 3, Turku Centre for Computer Science, Turku 1996.
- [39] Schoder, D. *Die ökonomische Bedeutung von Intermediären im Electronic Commerce*, Habilitation Univ. Freiburg, Freiburg 2000.
- [40] Teubner, R. A. *Organisations- und Informationssystemgestaltung: theoretische Grundlagen und integrierte Methoden*, Dissertation Univ. Münster, Gabler Verlag, Wiesbaden 1999.
- [41] Timmers, P. *Electronic Commerce*. John Wiley & Sons, Ltd, 2000.
- [42] Warnecke, H.J., Melchior, K.W., & Kring J. *Handbuch Qualitätstechnik: Methoden und Geräte zur effizienten Qualitätssicherung*. Landsberg/Lech: Moderne Industrie, 1995.
- [43] Wirtz, B.W. *Electronic Business*. Gabler Verlag, 2000.

# eBPS: A Strategic Framework for Successful Blueprint of E-Business Development

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## Abstract

Today's rapidly evolving e-Business environment demands a higher level of collaboration and integration within the enterprise and throughout the extended trading network. Many software vendors have proposed e-solution for e-Marketplace that optimize business processes and link trading partners via the web. However, understanding how to integrate e-Marketplaces with back-end business processes to capture the advantages of supplier relationship management, supply chain integration, pricing and revenue optimization and customer management relationship is not sufficient.

Over the past few years, leading companies are aiming for a leadership position with regard to electronic Business (e-Business) in their own industries. They are targeting for the position of being the e-Sponsor rather than being the e-Partner in their portal. In virtual market with global trading via cyberspace, giant enterprises are encountering many obstacles in even starting to convert their traditional business model to an e-Business model. It is therefore important to address the Business to Business (B2B) e-Commerce successful factors initially and how they pose challenges for multinational organisations.

This paper focuses on the planning issues in managing an e-Business initiative and proposes an eBPS (e-Business Partners System) model for strategic planning of e-Business project in a multinational company. This model provides a framework to for organizing a design plan of a customer-effective B2B e-Store.

**Key:** e-Business solution, portal, B2B, eBPS, strategic framework

## 1. Introduction

Today business is either going into B2B or not to be [1]. Cyberspace now offers virtual markets for small and big business to compete as equal players, with new procedures to reach customers and new culture to work with business partners. A lot of companies were out there running a race for on-line retail business where the winner did not win anything, tremendous Internet investment were committed and profit return did not lead to a breakeven [5, 6, 8]. Learning from the B2C electronic Business (e-Business) projects experience, B2B e-Business development is taking a much more tactic approach. Recent research in e-Commerce has been focusing on Internet marketing and Wireless Computing. The fundamental drive behind is the value chain system concept that aim for company's competitive advantages by providing a digital nervous system that integrates all relevant groupware under one common infrastructure, allowing companies to make sizeable jump in efficiency, growth and profits. Although the vertically integrated chain in companies does not have to exit anymore because we could interact with suppliers and customers along the entire value chain with the support of Internet and communication technology cheaply, our legacy experience in traditional business culture is valuable. The concept of Integrated Organizational System (IOS) had led to the development of Enterprise Resource Planning (ERP) system in early 90s and now the paradigm has shifted to how to transform the company's existing ERP system with e-Business features in 2000s. This requires extensive and in-depth business knowledge of the past and vision of the future.

This paper focuses on the important planning issue of e-Business initiatives in large companies. We propose a novel eBPS infrastructure that provides a strategic framework for designing customer-effective e-Commerce applications to ensure the minimum impact of changes, maximum checkpoints for informed control and design planning of a customer-effective B2B e-Store.

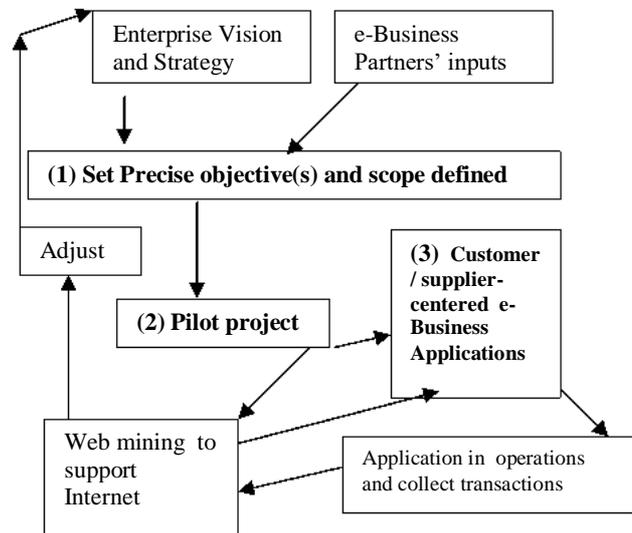
## 2. The eBPS Framework

Currently, e-Business is primarily about supply chain integration between buyers and suppliers which requires the integration of the purchasing process from the buyer, and the sales ordering process of the supplier [2]. Many software vendors claim to provide the state-of-art global e-business enterprise solutions for internet commerce that extend from front office Customer Relationship Management (CRM) to back office Enterprise Resources Planning (ERP) applications to platform infrastructure. However, the e-Commerce system is believed to have more managerial issues to resolve rather than technical issues. Based on the empirical study of many real world case studies which have attempted to catch up leader in E-Commerce, planning for strategic e-Business change, or prototyping e-Commerce strategies [4], the key constitutions of a successful e-Business planning could be summarized as follows:

1. Precise objective(s) and scope defined for business conversion (from traditional business to e-business) – Create change vision and change strategy.
2. Pilot project for secure procurement of e-Business development - Develop Leadership and build commitment.
3. Set up e-Business committee with key business executives to ensure the right progression of each checkpoint with support of change management – Manage people performance and progressively implement organizational changes.
4. Focus on customer centred (both e-customers and e-suppliers) design for customer-effective e-store or personalised web-site design – Develop culture.
5. Be a self-learning organization for quality assurance of e-services and sustainable profit in the fast changing marketplace – Deliver business benefits.

Many companies plan well, yet few translate strategy into action, even though senior management consistently identifies E-business as an area of great opportunity [8]. Hence, planning is important to ensure the implementation of the e-Business project is under control and carries out the plans for changes in e-Business strategies that were initially developed.

To clarify the inter-relationship behind these above critical success factors, below Figure 1 depicts our e-Business planning framework by means by an eBPS model. The following part of this section describes each of these steps that are built in into our proposed strategic framework.



**Figure 1: The eBPS Model – A Framework for planning e-Business initiative e-Business**

### Step 1: Objective and Scope

Multi-national companies often face critical questions in e-Commerce and they are required to be able to speedily response to change. This involves strategic planning and it is not just about technology. It is about how to use the Internet to reshape business. Competitors who have a more insight design in the development of their company web sites may destroy those who view it as a pure technology play. As such, the organizational needs and objectives of e-Business should be:

- (1) Lowered costs dramatically across their supply chains,
- (2) Taken their customer service to new levels,
- (3) Entered new markets and promote company new image,
- (4) Created new businesses opportunities and
- (5) Redefined their business relationships with the existing business profile.

Once the strategic plan is established with objective clearly defined, corresponding activities that required to be taken out to meet these objectives need to be managed and carried out. In B2B environment, one would seek control and management in business process and workflow optimization, legacy application integration, interoperability support, operational forecasting and planning. To kick off an e-Business project within a multinational enterprise, e-commerce roles and responsibilities must be assigned clearly and agreed according to the strategic plan set at the company board level.

The following scenario has taken Asia Pacific as the pilot region: -

### **The e-commerce roles and responsibilities**

Global teams, look at global aspects, some of these are: -

- Study impact of e-commerce on the enterprise
- Prioritization and controlling of projects
- Develop common platforms: Hardware, Software, Web appearance, Security, Data Structure
- Lead global projects which can not be allocated to regional business and global business
- Counsel business units and disseminate best practices
- Align with e-Commerce coordinators of global and regional business
- Identify e-venture opportunities
- Prepare / Evaluate proposal for e-Commerce Council
- Initiate change management process: Information & Training
- Define global standards for all aspects of e-commerce
- Develop and deploy global e-commerce building blocks
- Deploy the single face company presence on the web

Regional Teams, take care of regional activities, some of these are: -

- Participate in global committees to ensure the Asia Pacific regional requirements are included in the building blocks as these are defined and become available

- Continued participation in the global development & Testing to verify the availability of Regional requirements agreed upon.
- Build & deploy a regional Internet enabling architecture for the region.
- Roll Out the Active component solutions to local companies as they become available
- Manage the technical infrastructure for regional content database

E-Commerce/e-Business Development Team:-

- Responsibilities for overall regional e-commerce strategy and e-business development priorities
- Proactive co-ordination, sponsorship and development of global, regional and local e-commerce strategies & projects
- Identify, plan and accelerate the launch of promising e-business pilots / opportunities across Asia Pacific
- Effective e-commerce communication / education in the Asia Pacific region
- Active participation in global teams to define standard processes and ensure Asia Pacific region's business requirements represented.
- Define global, regional and local activities & responsibilities from Asia Pacific perspective. That is who can do what.
- Define the e-commerce business success factors for measures and evaluation.
- Supervise the deployment of 'local' web sites to ensure they do not conflict with global objectives.

All these above lengthy activities and considerations would be relatively non-technical but are critically important if an enterprise is to commit investment in a B2B e-Business project on the right track.

### **Step 2: Pilot Project Approach for Secure Development**

Years ago, companies had learnt their lesson on speedy e-Commerce development that had led to enormous maintenance cost and capital lost, and now many companies are being tied up with over scaled studies of protocol and its feasibility because of its insecure feeling of the dramatic changes in business practice. However, a quick start but under control move could compromise the dilemma and provides a first hand overview of the overall organizational e-business framework. This is beneficial to the later detail design of the e-Business

project procedure and protocol. We therefore propose to make e-business happens first without committing to uncontrollable lost, we suggest the implementing of a pilot project. The company could implement a pilot project by first setting up the new regional home page and its new country home pages, according to the global web-page design template, yet allowing individual local domestic features to exist. Secondly, pick a particular product line and convert its product information in database that is accessible to the new e-Business web-based application. Put it on-line for on-line ordering providing only with fixed price and delivery services. Thirdly, put up the advertising to attract awareness to potential business customers outside the traditional business scope. Fourthly, link up the (Vendor Managed Inventory) Supply Chain Integration where necessary. Companies could have many possibilities to build a pilot project on e-business:

- (1) Use of a B2B model on Extranet: The major issue here is to determine the list of key customers to be tested on its interactive information exchange. For example, receive forecasts and the purchasing orders, allow viewing of customer pricing, inventory levels, order status and return sales confirmation, delivery confirmation. This part would also concern the compatible issue of the company existing system(s), such as the integration to the Company's existing SAP or ERP systems.
- (2) Use of a "Business-Portal" or certain dot-com companies to test market penetration and/or sales growth potential to new customers.
- (3) Move the company regional business say, Asia Pacific aggressively into the e-commerce space by support high priority pilots and capture learning's for other initiatives.
- (4) Leverage a multi-dimensional task force to coordinate and drive initiatives. To do this, the project must have representatives from different regions and country organizations

Whichever way the company may decide upon the take off of pilot project, the objective is to maximize e-commerce benefits across all product groups and country organizations. As such, the important successful factors to B2B e-Business are: -

- Focus organization on high priority, high impact opportunities that can be scaled across

the region. It is important to avoid fragmentation to prevent future compatibility issue.

- Build regional consensus to address critical sales force, logistics, supply chain, customer care business process implications
- Integrate global initiatives to complement and/or build on regional approach.

The overall planning and control is critical when committing resources to kick off an e-Business project. The set up of a regional e-Business Committee to keep check on the pilot project milestones and interim deliverables is significant.

The following Figure 2 highlight the model of basic necessary checkpoints with expected deliverables after each milestone: -

Checkpoints	Activities and expected deliverables
First Global e-Commerce Meeting	<ul style="list-style-type: none"> <li>• 1st 'complete' meeting of all the regional representatives</li> <li>- gain the overall consensus on target agreement.</li> <li>• Partnership agreement between the Company and its suppliers companies and customers companies. Define:               <ul style="list-style-type: none"> <li>- Market place for procurement of the products / materials.</li> <li>- Market place for sales ordering of the product/services.</li> </ul> </li> <li>• Project team initiate for individual country e-Business strategy.</li> <li>• Define e-Commerce Global Key Account Plans.</li> </ul>

<p>Second Global e-Commerce Meeting</p>	<ul style="list-style-type: none"> <li>• Refine and review regional (Europe and US) e-Commerce: <ul style="list-style-type: none"> <li>– Review underway with each business unit to define its e-Commerce strategy.</li> <li>– Target completion schedule to be determined</li> <li>– Internal operations</li> </ul> </li> <li>• Analysis of competitive positioning in marketplace</li> <li>• Business Process Re-engineering Studies</li> <li>• Review the existing Organization SAP or ERP system: <ul style="list-style-type: none"> <li>- Identify the entry/exit point of company's existing system with the potential B2B e-Business web-site/application.</li> <li>- Design on the interface and data security/control issue.</li> <li>- Review of all existing web pages if existed.</li> </ul> </li> </ul>
<p>Third Global e-Commerce Meeting</p>	<ul style="list-style-type: none"> <li>• Promote &amp; support strategic change within the organization. And required with the implementation of e-Commerce initiatives</li> <li>• Action items <ul style="list-style-type: none"> <li>– Investigate and progress the formation of a "Global Business Community" with key</li> </ul> </li> </ul>

	<p>competitors.</p> <ul style="list-style-type: none"> <li>- Identification of Global Key Accounts and Nominate representatives</li> <li>- Technical support and Management control</li> <li>- Global coordination of web page development &amp; content management.</li> <li>- Development of Global e-Commerce database.</li> <li>-Implementation of Interface between new e-Business applications with company existing systems.</li> <li>-Continuous review and evaluation of 'market places'</li> </ul>
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**Figure 2: The 3 checkpoints with activities and expected deliverables**

Pilot projects need to be provided with an update on the status via checkpoints wherever possible to the entire key personal in the business and should have been screened by the MIS team of the enterprise, to establish an estimate of IT resource and functionality requirements. The update included details of proposed implementation timelines, functionality enhancements to the "On-Line Store" and the project cost assumptions. The task force "learning" on the pilot project should be discussed and agreed along the development of the enterprise's global e-store since it is important to experience and capture the learning to provide further insight into current "e-Readiness".

**Step 3: Customer-centered Approach for Customer-effective Web-sites Design**

The demanding knowledge of "know-how" has gone beyond the set-up and maintains of database through the web, both academia and industry are facing the challenges of how to design a web-site infrastructure that could provide optimal on-line experience that fit the e-customers' needs, acquiring the knowledge of "know-why" for learning and value adding. Increasing unique and unpredictable customer demands for innovation speed, quality and

service has not only compelled supply chain participants to rapidly adopt new e-Business practices but also provide personalized e-services. The discovery of e-customers' preference on web site surfing could be utilized to come up with an effective web-contents/infrastructure design and management. The need to segment and identify the target audience for Internet marketing had made the requirement of Internet users become obvious only recently. Many related studies have been investigated on a touch on basis. [7] discussed a 6 steps Interactive Marketing Process on the Internet, in which the initial step had emphasized the studies of e-customers' behavioral approach. [10] proposed a scheme on e-product characteristic for internet-marketing. [4] proposed a hypothetical customer theme represent common activities or processes, that a customers want to complete when they visit a particular web site. Use the theme to create scenario as a base to design web site content and its architecture. In any e-store, the bottom line is that any e-customer should be able to come to the web-site and complete an e-service process from beginning to end in a user-friendly and intuitively correct manner. We need to encapsulate all our web

3. mally addresses common areas of customer frustration or desire of new/extended activities) to relevant customer actions by easy accessible and visible utilitarian components.
4. The popular web pages with most diversify pre-requisite sequences and longest surfing time could be identified and refine appropriately with its page content and infrastructure with an aim that lead to actual order placement.
5. The isolated and inactivate web-pages could implied browsers are incapable of access to it, further analysis on these web-page content and its dynamic links are necessary, to decide upon whether metaphor on web site is necessary.
6. Based on the association semantic discovered and the targeted customers themes, we could create an intuitive navigation system that fit general customers' mental model support the seamless completion of critical processes. This could enable e-customers' understanding in the company web-site functionality with an intuitive interface.

site surfers' on-line experience, to discover the knowledge of customer behavior On line analytical tool could help to discover what web-pages led to the page for an order commitment is valuable. Many web pages de-motivated surfers with non-focused content and/or overwhelming the surfers or e-customers with information. We suggest web-content filtering by e-customer behavior studies is necessary and that only mission-critical web pages should survived in the ultimate B2B web-site infrastructure. This could better fit the e-customers' preference, time spent and also save cost on web-page maintain as well as improve the competitive advantage of the web site. The discovery of e-customer on-line preference could help the web site design team to meet the following criteria for designing a customer-effective web site:

1. Make web site functionality intuitive by restructuring it around e-customers' preferring processes.
2. Relate utility (web site functionality that allow browsers do something useful to serve them better and faster, they nor

#### 4. Conclusion and Future work

Planning is a vital organization process that helps organization to learn about itself and promotes organizational changes and renewal for improvement. Strategic e-Business planning involves aligning investment in information technology with company's e-Business vision and strategic goals such as business process re-engineering, IT strategies and technology architecture. It results in a conceptual blueprint that specifies a company's e-Business targets, data resources, and applications architecture and technology platform. This paper has presented an eBPS strategic model with infrastructure that provides a framework for developing a blueprint to build a customer-effective e-Business within a multi-national company, with particular emphasis on minimizing changes by secure pilot project approach and maximizing control by implementing global checkpoints with e-Business committee set up. B2B e-Business application is complex and its development processes demands intensive intelligent both technically and managerially. Our proposed eBPS model which aims for minimum impact of changes and maximum communication is focused on the four important key requirements for successful B2B development. They are the :-

- (1) Objective-driven strategic planning for effective communication and minimum changes,
- (2) Pilot project approach for secure development,
- (3) Check points scheme verified by e-Business committee for informed control and
- (4) Customer-centered approach in customer-effective web-sites design for organizational learning.

The future direction of this research would focus on the design of inter-organizational system with support of business process redesign and the adoption of enabling Internet technology to realize the benefit of value chains with minimum impact of procedural and cultural changes.

## **Reference**

- [1] Brandon Cople, (2000) "B2B or not to be?" Forbes, August7,2000, pp.34 - pp.35.
- [2] Cox Tim (2001) "Two hats two jobs" The Asset, February, 2001, pp. 22 – pp. 23.
- [3] David Anderson (2000) "Managing Information Systems - Using Cases within Industry Context to solve Business problems with IT", Prentice Hall
- [4] Jodie Dalglish "Create Customer-Effective E-Services" e-Business Advisor, December, 2000 pp.26 – pp.32.
- [5] Heda Bayro & Daniel Yu (2000) " The B2B market revolution ..Is it for real ?", The Asset, June, 2000, pp.40 – pp.43.
- [6] Jeffery F. Rayport & Bernard J. Jaworski (2001) "e-Commerce", McGraw-Hill/Irwin MarketspaceU, pp.69 – pp.110.
- [7] Kalakota and Whinston (1996), "Frontiers of Electronic Commerce", Addison Wesley, pp.215 – pp.292.
- [8] Kalakota, Ravi and M.Robinson (1999), " E-Business: Roadmap for Success", Reading, MA: Addison Wesley.
- [9] Malone T., Yates J. & Benjamin R., "The logic of electronic market" Harvard Business Review, 1989 pp166-171 May-June.
- [10] Melody Y. Kiang, TS Raghu and Kevin HM Shang (2000), " Marketing on the Internet – who can benefit from an online marketing approach?", Decision Support Systems and Electronic Commerce, Elsevier, Volume 27, pp383-393

# The Key Successful Factors of Internet Business: The Study of Online Bookshop

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## Abstract

Electronic commerce is viewed as a more and more important issue for the rapid growth of online commercial activities. The books, having the properties of numerous categories, low unit price, and the convenience of delivering, have become the major products on line. So the online bookshops are appropriate for study to find out the key successful factors of Internet business. We first conduct twice Delphi to confirm several factors that are important to success in Internet business and there are 32 factors to be chosen. We then calculate the relative weight of each factor with the Analytic Hierarchy Process (AHP) and select 14 factors having the highest weight to be the key successful factors of Internet business. These 14 factors in order of weight include the ability of managing the business change, filling the Place with Entrepreneurs and growing with them, the ability of managing the customer relationship, targeting the right customers, the price can react to market quickly, building the knowledge management systems, excellent sever ice after payment, building distribution center to develop unbeatable logistics, the ability of managing the cost, offering Great Value, the ability of marketing by database, building the goodwill and brand image, getting the trust of virtual community and maintain it continually, and the ability of developing the technology.

## 1. Introduction

U.S.A. applied Internet originally to military and education in cold war. After the application of World Wide Web (WWW) in 1989, Internet even played a more and more important rule in our life. Because of the superiority of Internet, which provides worldwide service, increases markets occupy rate, and dramatically decreases cost of communication, many operators start to develop Internet commerce. A foreign noted research institute, e-Marketer, predicts the market scale of global online

consuming will grow at the compound annual growth rate (GAGR) of 93% from 1999 to 2003.

After the depreciation of U.S. NASDAQ Internet stocks, B2C e-commerce shopping web sites, no matter local or foreign, tend to cut off their cost and transform their operating mode. However, Market Intelligence Center (MIC), followed by investigation of online shopping market in Taiwan, points out that because the boost of net-surfing population, maturation of e-commerce as well as payment mechanism, and blooming growth of online application, such as online game, internet stock booking, and web-advertisement, it's estimated that it will grow as high as 64% GAGR in three years to come. In addition, the needs of AV entertainment and living requirement are going to increase rapidly in three years [5]. Moreover, MIC claims that those who integrate the "resource of Internet and substantial channel" will be the main stream of market in the future. Building up the Internet consuming concept and strengthening related ordinance would be the key point of online shopping market.

Because books have the traits of variability, complication, low unit price, and convenient transportation. In addition, thanks to the combination and introduction of virtual community, books are suitable for sale online [22]. In this research, we think online bookshop is pretty representative of Internet industry. As a result, taking online bookshop for example, we want to explore successful Internet industries' key successful factors, which could be the blueprint of resource allocation priority.

In the concrete, the goal of the research is to understand the operation condition of online bookshop and factors affecting the operation performance, furthermore, to analyze the key successful factors of operation, which provide a direction of strategy for Internet operators and help them to face the variable environment.

## 2. Literature Review

### 2.1 Electronic Commerce

Electronic Commerce (E-Commerce, EC) is described as "the capability of buying and selling products on the Internet and other online services"[10]. Generally, the business transactions that conducted in Internet technology such as computer, information networks, electronic data exchange (EDI) and so on are called EC.

The definitions of EC vary with different perspective [10]. In communication perspective, EC is the delivery of information, products/services, or payments over telephone line, computer networks or any other electronic means. In business process perspective, EC is the application of technology toward the automation of business transactions and workflow. In service perspective, EC is a tool that addresses the desire of firms, consumers and management to cut service costs while improving the quality of goods and increasing the speed of service delivery. In On-line perspective, EC provides the capability of buying and selling products and information on the Internet and other online services. Communication process service on-line definition

EC are divided into three broadly recognized categories: intra-organizational, Business-to-Business (B2B), and Business-to-Consumer (B2C) [10]. Intra-organizational EC includes facilitating the organizational internal function and increasing the satisfaction of target customer. B2B EC is referred to facilitate and integrate the network form between organizations. B2C EC, is referred to improve the transaction between business and customer with electronic technique. Offering products/services in Internet is a kind of B2C EC and it is named as B2C. Making profit from the advertisement by establishing website attracted stream of people is another kind of B2C EC and it is named as C2B.

The key of B2B EC is to establish good relationship with the co-operational partner. C2C EC is stressed on the credit of buyer and seller. Otherwise, B2C EC put more importance on security and identification. The key of C2B EC is to attract a great number of visitors to browse the website. The Internet business we discuss in letter is focused on the B2C EC.

### 2.2 Online Bookshop

Online Stores is a kind of virtual store that consumers can purchase what they want in Internet [6]. In broad sense, online Store is defined as that consumers can order the products/services on line. In this definition, if the website only offers the information of products/services, but consumer have to order it through telephone,

fax, transfer, mail and so on, it is not on-line store. In narrow sense, online Store is defined as that all the processes of transaction, such as browsing, ordering and paying, can be done in the Internet. According to the type of products, on-line store is divided into direct commerce and indirect commerce. The deals of the digital or un-physical products are called direct commerce and the deals of the physical products are called indirect commerce [16].

Online bookshop is the virtual store that consumers can order or purchase the books on the Internet. The Online bookshops in Taiwan are divided into three groups according to their background.

#### 2.2.1 Pure Virtual Online Bookshops

Most of them were established by internet technology company. Although they did not have physical recourse, they have the Internet technology, such as e-Commerce, and operate a new brand, for example, books.com.tw and silkbook.com.

#### 2.2.2 Publishers- Established Online Bookshops

They often establish their own website as a new channel to expand their business. On their website, although they sell the books issued by other publisher, they give first places to sell the books issued by themselves, for example, YLib.com and cwbook.com.tw.

#### 2.2.3 Tradition- Established Online Bookshops

Traditional bookshops can establish their own website with the advantage of business experiences. Most of them have great database and comprehensive products, for example, kingstone.com.tw and soidea.com.tw.

Online bookshops have the advantages of globality, convenience, interaction, personalization, low rate of returned goods, and no pressure of stocks [12][14]. However, the online bookshops in Taiwan now still have some dilemmas. For example, on-line shopping is not popular yet; especially books-selling. Consumers still have doubts about security. The speed of transmission is sluggish. And the Chinese books market is far smaller than English books [12][14].

That analyzing the industry value chain of final product is a quick way to discover the key successful factors [21]. We seek out the value chain of online to help to establish the key successful factors. Traditional book-selling processes -- publish, print, general sells, and retail--play a part of new value chain and Internet processes play another part. In the new value chain of online bookshop, the business processes include the publishing, printing, purchasing from publisher, information systems of online bookshops, database of books to sell, all the data of consumers, the channels from

wholesale to retail, storing, transporting the books to consumers, website image, and website.

### 2.3 Key Successful Factors

Key Successful Factors (KSFs) are the characteristics, abilities, or assets of enterprise that can improve significantly their power to compete [1][2][7][11][18][21]. If organizations can keep their KSF, they can utilize their resources more efficiently and improve their performance [3][17]. Then they can strengthen the advantage to succeed in specific industry [6][11][18]. Each industry has its own different environments, so that the KSFs in specific industry are different to each other. To Sum up the KSFs in this study are the characteristics, abilities, or assets of enterprise to keep its persistent competition advantage with utilizing efficiently its resources in these critical factors.

### 2.4 Key Successful Factors of Online Bookshop

The major purpose in this study is to discover the KSFs of online bookshop, and these KSFs will be involved in the critical factors of virtual shop. Several researchers addressed different critical factors and we find that some of the factors are similar.

1. There are five keys to create a successful virtual store [23]: (1)setting goals (2)understanding and creating the shopping experience (3)getting to know customers (4)advertising and promoting the store (5) implementing a payment system.
2. A successful business strategy of internet shop should include [9]: (1)decreasing the cost of purchasing, transportation and storing (2)increasing the revenue by using the price strategy flexible (3)building a complete back-end systems (4)recognizing the commerce effects of traditional mass media (5)building the identifying systems (6)making an excellent internet marketing (7)putting the customer first (8)emphasizing the security and customer privacy (9)holding the promotion (10)increasing the customer loyalty.
3. A successful Internet shop store should include ten functions [13] such as (1)satisfying variable user with different connecting rate (2)collecting consumers' database (3)establishing good interaction between users (4)providing multiple purchase way. (5)ensuring transaction safety (6)using proxy program to increase service quality (7)providing a rich customerized information (8)friendly users' interface (9)fluent website framework. (10)calculating the times of website visiting.
4. Eight critical success factors are induced for successful modern businesses [20]: (1)targeting the right customers (2)owning the customer's total experience (3)streamlining business processes that impact customers (4)providing for a 360-degree view of the customer relationship (5)letting customers help themselves (6)helping customer do their jobs (7)delivering personalized service (8) fostering a community.
5. EC business managers should allocate their important business resources on activating the seven kinds of effects to keep their competition advantage [15] (1) learning effects: developing the ability to accumulate the Internet resources and experiences (2)network effects: developing the ability to operate the Internet community (3)uniqueness effects: developing the ability to collect the customers' preference (4)pricing effects: developing the ability to make discriminated price (5)efficiency effects: developing the ability to operate efficiently and improving the convenience of cross-organization (6)searching effects: developing the ability to build virtual agency (7)cooperation effects: developing the ability to make the strategy alliance.
6. Ten rules are captured with the requisite of Amazon [19]: (1)living and breathing E-Commerce (2)filling the place with entrepreneurs (3)focusing (4)branding the site (5)getting and keeping customers by offering great value (6)developing unbeatable logistics (7)staying lean (8)practicing Technoleverage (9)constantly reinventing the business (10)growing with the best.
7. Successful factors of online bookshop include [8]: (1)ensuring the bookshop orientation and providing specific service to targeted customers. (2)friendly interface and accurate search result. (3)rich book information. (4)using the customerized content and interaction to reinforce community coherence. (5)digitalized property and ability. (6)competitive price. (7)the cooperation of publisher, distributor, conveyer, media and writer. (8)the cooperation of online bookshop, ISP, and search engine. (9)brand publicity is the obstacle of follower, however, pioneer are not necessarily predominant in establishing its brand. (10)paying attention to professional ability.
8. After analyzing the characteristics of online bookshop in Taiwan, it discovers 15 essential factors [4]: (1)collection of books. (2)offering online credit card and booking service. (3)low transportation charge. (4)interaction between reader, writer, and online bookshop. (5)interaction among readers. (6) providing online full-text search. (7)issuing e-paper about culture. (8)detail information of books. (9) more discount. (10)organizing a strategy coalition with local and foreign business. (11)fast and perfect service before and after payment. (12)constructing its

own brand and publicity. (13)launching variable promotion and service periodically. (14)a bait to urge customers to visit. (15)software and hardware update.

### 3. Research Design

#### 3.1 Building The Key Successful Factors

From this review of research, this study induced 39 factors, important for managing the online shop, to be the items of Delphi questionnaire. Upon the result of Delphi questionnaire, we delete 7 factors that are not as important

as others and use the remnants (32 factors) to be the items of AHP (The Analytic Hierarchy Process). Figure 2 is the framework to find out the KSFs with AHP. Figure 2 is shown that there are 32 items, 8 dimensions (8 kinds of effects), and one target. With AHP, we compared the 32 items by pair to evaluate the relative weight of each item to find their relative importance to the dimension. With the same way, we evaluate the weight of each dimension to find their relative importance to target. Then we can assess the relative weight of items to the target.

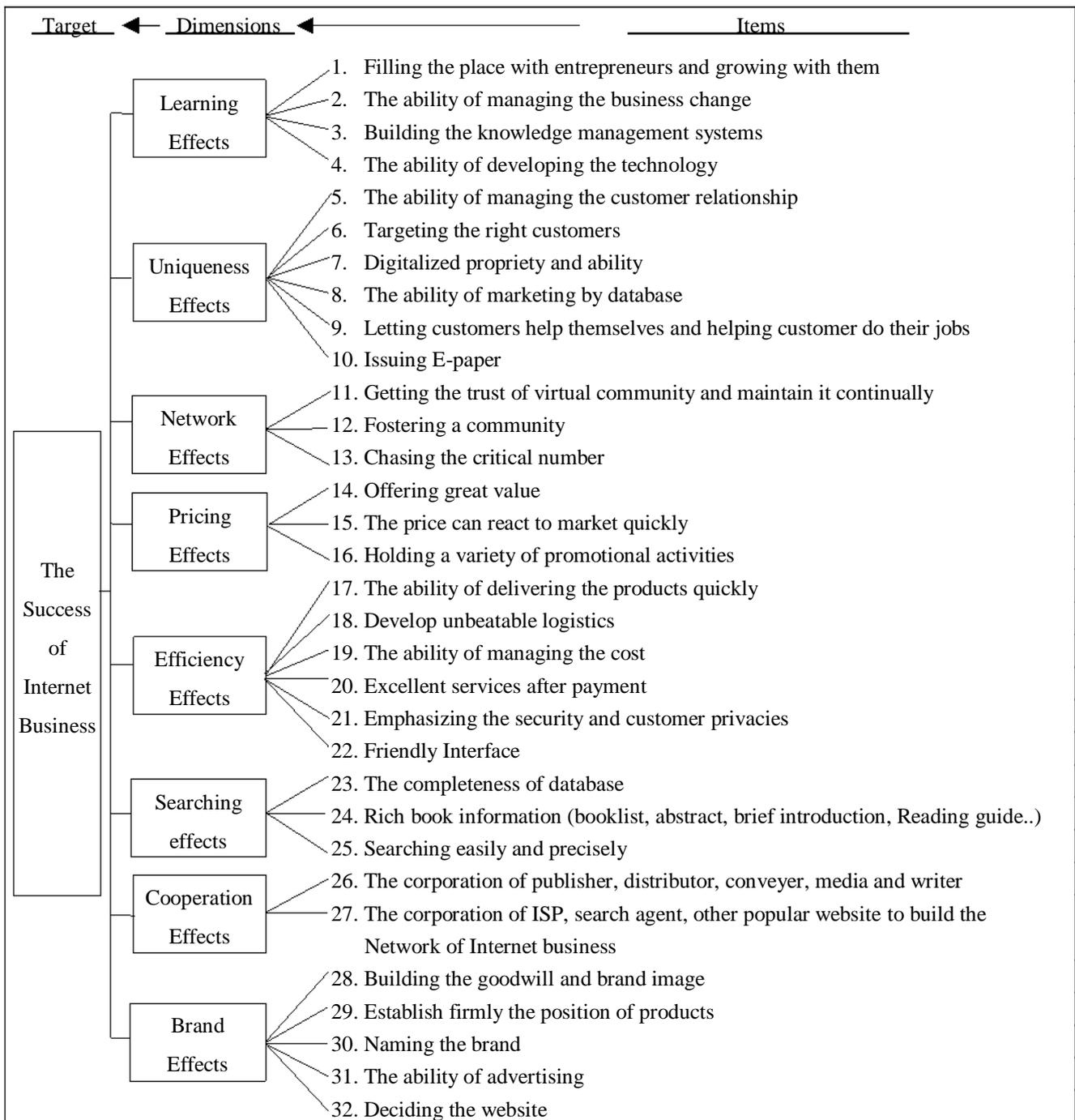


Figure 1 The key successful factors of online bookshops

Table 1 Questionnaire survey

		Release	Collect	Valid	Valid (%)
Delphi (First)	Managers of pure virtual bookshop	3	3	3	100
	Managers of online bookshop with physical store	1	1	1	100
	Managers of online bookshop establish by publisher	4	4	4	100
	Scholars	8	8	8	100
Delphi (Second)	Managers of pure virtual bookshop	3	3	3	100
	Managers of online bookshop with physical store	1	1	1	100
	Managers of online bookshop establish by publisher	4	3	3	75
	Scholars	8	7	7	87.5
AHP	Managers of pure virtual bookshop	3	3	3	100
	Managers of online bookshop with physical store	1	1	1	100
	Managers of online bookshop establish by publisher	4	4	4	100
	Scholars	8	8	8	100

### 3.2 Questionnaire Design and The Object

We conduct a survey on specialists by three phases. In the first and second phase, we conduct Delphi questionnaire twice to integrate the opinions of specialists and construct the items of AHP questionnaire. In the third phase, we carry out the AHP questionnaire to find out the KSFs. The scope of specialists should include various kinds of scholars, online bookshop manager, and other related managers. We choose eight specialists to be the objects that include the managers of pure virtual bookshop, the managers of online bookshop belonging to physical store, the managers of online bookshop established by publisher, the supplier of equipment, and

the scholars. We obtain 7 to 8 valid questionnaire in three phases (Table 1). The criterion to judge the validness of AHP questionnaire is assessing the consistency ratio (CR) with software, Expert Choice. The AHP questionnaire is valid if the CR is lower than 1.

## 4. Results and Discussion

### 4.1 Analysis of Delphi

We use five-scales approach to measure the degree that items will affect the successes of Internet business. The higher means that the object thinks the items is more important. The mean scores and standard deviation of twice Delphi questionnaire are shown as Table 2.

Table 2 The results of Delphi

dimension	Original evaluated items	Fist time		Second time		Delete
		Means	Standard deviation	Means	Standard deviation	
Learning Effects	A1.Filling the place with and growing with entrepreneurs	4.43	0.53	4.4	0.55	
	A2.The ability of managing the business change	4.14	0.69	4.2	0.84	None
	A3.Building the knowledge management systems	4	0.82	4.2	0.45	
	A4.The ability of developing the technology	3.86	1.07	4.2	0.45	
Uniqueness Effects	B1.The ability of managing the customer relationship	4.86	0.38	5	0	
	B2.Targeting the right customers	4.57	0.79	4.8	0.45	
	B3.Digitalized propriety and ability	4.29	0.95	4	0	None
	B4.The ability of marketing by database	4	1*	4.4	0.55	
	B5.Letting and helping do their jobs	3.43	0.98	3.8	0.45	
	B6.Issuing E-paper	3.43	1.27	3.2	0.84	
Network Effects	C1.Getting the trust of virtual community and maintaining It continually	4.14	0.9	4.2	0.84	None
	C2.Fostering a community	4	1*	4	0.71	
	C3.Chasing the critical number	3.43	1.27*	3.2	0.45	

dimension	Original evaluated items	Fist time		Second time		Delete
		Means	Standard deviation	Means	Standard deviation	
Pricing Effects	D1.Offering great value	4.14	0.69	3.8	0.45	
	D2.The price can react to market quickly	3.86	0.69	3.4	0.55	
	D3.Holding a variety of promotional activities	3.71	1.25*	3.6	0.55	D4, D5
	D4.The ability to make discriminated price	2.71**	1.11*	2.4**	0.55	
	D5.Not charging postage	2.71**	0.49	2.6**	1.14*	
Efficiency Effects	E1.The ability of delivering the products quickly	4.71	0.49	4.6	0.55	
	E2.Develop unbeatable logistics	4.57	0.53	4	0.71	
	E3.The ability of managing the cost	4.57	0.53	4.4	0.55	
	E4.Excellent sever ice after payment	4.57	0.53	4.6	0.55	E7
	E5.Emphasizing the security and customer privacies	4.57	0.79	4.2	0.84	
	E6.Friendly Interface	4.43	0.53	4	1.22*	
	E7.Providing various way of payment	4	0.82	3	0.71	
Searching Effects:	F1.The completeness of database	4.29	0.76	4.2	0.45	
	F2.Rich book information	4	0.82	4.4	0.55	
	F3.Searching easily and precisely	3.71	0.76	3.8	0.84	F4, F5
	F4.Interface with various languages	3.14	0.69	2.8**	0.45	
	F5. Diversified enterprise	2.43**	1.4*	2.2**	0.45	
Cooperation Effects:	G1.The corporation of publisher, distributor, conveyer, media and writer	3.86	1.21*	4	0.71	
	G2.The corporation of ISP, search agent, other popular website to build the network of Internet business	3.29	0.95	3.4	0.9	G3, G4
	G3.Having own complete channels	-	-	3	1.22*	
	G4.The ability to publish by itself	-	-	3	1.22*	
Brand Effects:	H1.Building the goodwill and brand image	4.29	0.95	4.6	0.55	
	H2.Establish firmly the position of products	4.14	1.21*	4	1*	
	H3.Naming the brand	4	1.15*	3.4	0.55	None
	H4.The ability of advertising	3.86	1.35*	3.8	0.45	
	H5.Deciding the website	3.29	1.38*	3.2	0.84	

\*\* :the means below 3 \* :the standard deviation above 1

In the first Delphi, there are twelve items have higher standard deviation (over than 1), but there are only 3 items have higher standard deviation in the second Delphi. It indicates that the specialists have the consistency about the 32 items of the second Delphi. According to the means scores of Delphi, we choose the items whose score is above 3 to be the items of AHP questionnaire. In this criterion, there are 7 items not being selected.

#### 4.2 Analysis of AHP

The 32 items of AHP questionnaire come from the

Delphi. We count the items' relative weights in each valid AHP questionnaire by Expert Choice. There are 84 set weigh values totally. Let the means of 84 set weight values to represent the weight of each item. The process and analysis of AHP are described as followed.

We compute the degrees of eight dimensions influencing the successes of Internet business by pair compared matrix. Then we compute the weights of the items under each dimension. According to the matrix, we can obtain the eigenvectors of each dimension (Table 3) to infer the KSFs of the successes of Internet business. After

Table 3 The eigenvectors of eight dimensions

Dimension	Learning effects	Uniqueness Effects	Network effects	Pricing effects	Efficiency effects	Searching effects	Cooperation effects	Brand effects
Eigenvectors	0.245	0.188	0.065	0.102	0.215	0.060	0.038	0.087

Table 4 The rank of the degree of items affecting target

Rank	Items		Weight*1000
1	A2	The ability of managing the business change	99.96
2	A1	Filling the place with entrepreneurs and growing with them	65.42
3	B1	The ability of managing the customer relationship	58.84
4	B2	Targeting the right customers	49.82
5	D2	The price can react to market quickly	47.53
6	A3	Building the knowledge management systems	46.06
7	E4	Excellent sever ice after payment	45.80
8	E2	Develop Unbeatable Logistics	43.22
9	E3	The ability of managing the cost	41.28
10	D1	Offering great value	39.78
11	B4	The ability of marketing by database	38.16
12	H1	Building the goodwill and brand image	34.37
13	C1	Getting the trust of virtual community and maintain it continually	33.74
14	A4	The ability of developing the technology	33.57
15	E1	The ability of delivering the products quickly	32.47
16	F1	The completeness of database	29.34
17	E5	Emphasizing the security and customer privacies	26.66
18	E6	Friendly Interface	25.37
19	G1	The corporation of publisher, distributor, conveyer, and writer	24.43
20	C2	Dictating fostering a community	24.12
21	H2	Establish firmly the position of products	20.10
22	F2	Rich book information	17.34
23	B3	Digitalized propriety and ability	16.36
24	D3	Holding a variety of promotional activities	14.79
25	H3	Naming the brand	14.01
26	B5	Letting and helping customer do their jobs	13.72
27	G2	The corporation of ISP, search agent, other popular website to build the network of Internet business	13.57
28	F3	Searching Easily and Precisely	13.26
29	B6	Issuing E-paper	11.09
30	H4	The ability of advertising	10.79
31	H5	Deciding the website	7.74
32	C3	Chasing the critical number	7.15

we integrate all the computation mentioned above, we could obtain the weights of all items and rank them to help us find the degree of items affecting target (Table 4).

According to the weight values from the sample, we rank the degree of the eight dimensions affecting the target (the successes of Internet shop). Learning Effects is the most important dimension (24.5%), and the other dimensions are in the order of Efficiency Effects(21.5%), Uniqueness Effects(18.8%), Pricing Effects(10.2%), Brand Effects(8.7%), Network Effects(6.5%), Searching

Effects(6%), and Cooperation Effects(3.8%).

We also can rank the influence of 32 items affecting their own dimensions in proportion to the weight value from the sample. The results are shown as followed:

1. The four items to evaluate “Learning Effects” are the ability of managing the business change (40.8%), filling the place with entrepreneurs and growing with them (26.7%), building the knowledge management systems (18.8%) and the ability of developing the technology(13.7%)

2. The six items to evaluate “Uniqueness Effects” are the ability of managing the customer relationship (31.3%), targeting the right customers (26.5%), the ability of marketing by database (20.3%), digitalized propriety and ability (8.7%), letting customers help themselves and helping customer do their jobs (7.3%), and issuing E-paper (5.9%).
3. The three items to evaluate “Network Effects” are getting the trust of virtual community and maintain it continually (51.9%), fostering a community (37.1%), and chasing the critical number (11%).
4. The three items to evaluate “Pricing Effects” are the price can react to market quickly (46.6%), offering great value (39%), and holding a variety of promotional activities (14.5%).
5. The six items to evaluate “Efficiency Effects” are excellent sever ice after payment (21.3%), Develop unbeatable logistics (20.1%), the ability of managing the cost (19.2%), the ability of delivering the products quickly (15.1%), emphasizing the security and customer privacies (12.4%), and friendly Interface(11.8%).
6. The three items to evaluate the “Searching effects” are the completeness of database (48.9%), rich book information (28.9%), and searching easily and precisely (22.1%)
7. The two items to evaluate “Cooperation Effects” are the corporation of publisher, distributor, conveyer, media and writer (64.3%) and the corporation of ISP, search agent, other popular website to build the network of Internet business (35.7%).
8. The five items to evaluate “Brand Effects” are building the goodwill and brand image (39.5%), establish firmly the position of products (23.1%), naming the brand (16.1%), the ability of advertising (12.4%), and deciding the website (8.9%)

In General, there are no certain numbers of KSFs, because each specific industry has its own special consideration. According to the weight value of each item, we could find that the accumulative weight values of former 14 items (Table 6) are about 70% of the total amount. So we select these 14 items as KSFs of successful online bookshop.

## 5. Conclusions and Limitation

### 5.1 Conclusions

If we divide the key successful factors into eight dimensions and weight its importance, we will get the

order of study, efficiency, price, brand, Internet, search and unite effort. If we explore the key successful factors of success by items, there are 14 important items whose accumulation weights reach 70%. As a result, they can be treated as key factors. According to the priority of weight, we can give following order: (1) the ability of managing the business change (2) filling the place with entrepreneurs and growing with them (3) the ability of managing the customer relationship (4) targeting the right customers (5) the price can react to market quickly (6) building the knowledge management systems (7) excellent sever ice after payment (8)Developing unbeatable logistics (9) the ability of managing the cost (10) offering great value (11) the ability of marketing by database (12) building the goodwill and brand image (13) getting the trust of virtual community and maintain it continually (14) the ability of developing the technology. The practical value of the research is that it offers a reference for online bookshop. When enterprise is hesitant to make a decision, it can refer to the list of priority and set all the condition in balance.

### 5.2 Limitation

The boundary of the research is that the framework, which is suite for assessment of online bookshop, is designed only by the consideration of items. Taking labor and time into consideration, the number of questionnaire and sample collection is not enough; therefore, it cannot reach significance. It betters off to discuss with online business operators from different direction. Besides, it is not mentioned in the research that whether the overlap of AHP and Field sampling will infect the result of Field questionnaire.

### 5.3 Following Research And Suggestion

Because it is short of time and money, this research only analyzes the weight of effectors of online business operation and lists the key successful factors. However, there are some aspects insufficient, which need subsequent studies: (1) Find out an example among all of the online stores. Compare it with 14 key effectors and testify the result. (2) According the eight items, do more detailed analysis, experts interview to collect more comprehensive items, and discover the key factors of online business operation. (3) Expand the sample scope to other type of online stores, not just only online bookshop, to understand the operation environment more

## Reference

- [1] Aaker, D.A. *Strategic Market Management*. NY: John Wiley & Sons Co, 1984.
- [2] Barnard, Chester I. *The Functions of the Executive*. Harvard University Press 5, 1984.
- [3] Boynton, A. C. & Robert W, Z. "An assessment of critical success factor". *Sloan Management Review*, Summer, 17-27,1984.
- [4] Ding, X. Y. *The Strategy in the Internet Age*, Taipei: Rand, 2000.
- [5] Gong, J. L. "Discuss The Future of E-Commerce from the view of Internet laying off " Retrieved from <http://mic.iii.org.tw>, 2001.
- [6] Internet application Project, "The general description of E-Commerce," Retrieved from <http://www.ec.org.tw/upload/19991028134348.doc>, 1999.
- [7] Hofer, C. W. & Dan, S. *Strategy Formulation : Analytical Concept*. West Publishing Company, 1978.
- [8] Hu, M. Y. *Key Successful Factors to Internet Business ---Case of Online Bookstore*, The unpublished dissertation, National Zheng-Zhi University, 1988.
- [9] Huang, Z. J. "The Strategy of Online Stores," *Information and Computer*, 1997.
- [10] Kalakota, R. & Whinston, A. B. *Electronic Commerce: A Manager Guide*, USA: Addison- Wesley Publishing, 1997.
- [11] Leidecker, J. K. & Albert V. B. "Identifying and Using Critical Success Factors," *Long Range Planngge Planning*, Vol. 17:25, 1984.
- [12] .Li, H. R. "The Existence of Online Bookshop," *Journal of Yin-Yi*, Vol. 1, 1998.
- [13] Lin, T. S. & Wang, J. P., *The Functional Design and Need of E-Commerce Online Bookshop*, The unpublished dissertation, National Zhong-Shan University, 1987.
- [14] Ling, S. Y., "The Present and Future of Bookshop," *Journal of Internet Pioneer*, Vol. 47, 1998.
- [15] Lu, H. P, "The Seven Effects of the competition in E-Market: Based on the Theory of Poerter," *The 36 Key points to Gain Internet Advantage*, Taipei: Shang-Zhou, 1988.
- [16] Michel, .L. D. *What Will Be: How the New World of Information Will Change Our Lives*. Harpercollins, 1997.
- [17] Miller, A. .*Strategic Management*. NY: McGraw-Hill, 3rd Edition:124 –125, 1998.
- [18] Rockart, J. F. "Chief Executives Define Their Own Data Needs," *Harvard Business Review*, May 1980:85, 1980.
- [19] Saunders, R. *Business the Amazon.com Way– Secrets of the Word’s Most Astonishing Web Business*, Dover, NH: Capstone, 1999.
- [20] Seybold, P. B. & Marshak, R. T. *Customer.com: How to create a profitable business strategies for the Internet and beyond*, New York: Random House, 1998
- [21] Wu, Si-Hua *Industry Policy and Business Strategy*, China Economy Research Center, 1989.
- [22] Yam Digital Technology "The survey of Internet in Taiwan in 2000", Retrieved from <http://survey.yam.com/survey2000/index.html>, 2000.
- [23] Yesil, M. *Creating the Virtual Store: Taking Your Web Site from Browsing to Buying*. Cybercorp: The New Business Revolution, James Martin, 1996.

# Study on the Present Condition, Tendency and Countermeasure of E-Business in China

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## Abstract

With the coming of a new century, the situation of EB in China has been greatly improved. Followed by the development, the pressures in and out of China may become the engine of EB in companies, and will further stir up a fashion. Under these backgrounds, it is urgent for relative sectors of government, industries, research centers and commercial sphere to fully prepare for the tide of EB, for the purpose of acting excellently in the array of EB.

Key words: the present condition of EB; the tendency of EB; the countermeasure of EB

Since 1990s, with the quicker steps of economy globalization, trade liberalization and information modernization, EB, which is a modern productive force created by the combination of information, commerce and management technology, now is propelling department economy, district economy, national economy and world economy to get on a new step.

Coming to the 21st century, after several years' hard exploration and active effort, the situation of EB in China has been greatly improved, and the tendency of EB in China has had an inkling of the matter. So it is more important for us to study on the following countermeasure.

## 1. The Present Condition of EB in China

Up to the end of 2001, EB in China had achieved satisfactory progress in several aspects, such as foundation facilities, program law and regulations, theoretical research and applied practice. It mainly shows as followed:

### 1.1 Fast Developing Foundation Facilities[1]

#### 1.1.1 Computer Network Has Made Marked Development

The four core members of network (scientific research, education, telecommunications and economy) augmented capacity and increased speed one after another. The submarine optical cable between China and America was successfully laid in January this year, so that it can provide 1000 thousand couples of information source corresponding at the same time. Before the end of this

year, the outlet bandwidth of China telecommunications will get to 150M, and the whole bandwidth of network will get to about 345M. The number of domestic net men gets double every six months, and by the end of this year, it will have reached 9900 thousand. The number of websites in Chinese has been more than 15 thousand.

#### 1.1.2 Telephone Network Increased Rapidly

Telephone network of the whole country has attained program control. The number of fixed telephones has topped 1000 million, and that of mobile telephones has topped 5 million. It means that 13 percent of whole Chinese people has had telephones.

#### 1.1.3 Television Network Has Basically Covered The Whole Country

There have been 300 million television sets all over the country. If a family is regarded as holding four persons, almost every family has had a television set.

#### 1.1.4 Communication Network Has Varied Developed

Optical fiber, microwave and satellite television have formed a core communication network.

#### 1.1.5 It Has Basically Realized Mutual Dependency Among Networks

The technology and product have been successfully manufactured to realize mutual dependency among computer, telephone and television networks, and have been put into use.

#### 1.1.6 The Terminal Products Of EB Have Come Out In 2001

They are telephone, computer, credit, integration terminal and Venus for network etc.

## 1.2 Rapidly Building Program Law And Regulations[2]

(1) Since 《The development framework of EB in China》 drafted by China Information Industry Ministry was issued in July 1999, it has consulted the broad department. If these suggests will be approved, it will come out as 《The National Program for EB Strategy》.

(2) The monographic deliberate meeting presided by Information Industry Ministry was convened to discuss the construction of EB Law.

(3) According to local situation, some districts have formulated their own EB planning. For example, the government of Shenzhen City has organized to draw up 《The Five-Year-Planning of EB Development in Shenzhen City 》. After further discussing, it will be reported for approving.

### 1.3 Actively Carrying Out Security Activity

(1) National government have issued several safe regulations about communication network and Internet.

(2) There have been many EB centers of attestation, some of which have passed the appraisal of ministry and state.

(3) Many commercial banks such as agricultural bank of China, China bank and industrial and commercial bank of China etc. have built up payment gate of network and offered payment and settling accounts by network one after another.

(4) The work to train talent has started. Some Universities have offered the courses and specialties about EB and some have provided the personnel at EB posts for training.

### 1.4 Rapidly Developing the Application of EB

(1) More than half of the governments in all levels have used network. By the end of 2000, the government network project initiated by above forty ministries and committees had shown remarkable success, including 68 ministries and committees using network, two-thirds of provinces and city governments using network to issue information, more than 2300 governmental websites and seventeen trades information websites being built.

(2) Economic departments use network one after

another. National network of finance, tax and trade has partly started, which promotes a series of golden projects.

(3) It has been effective for some enterprises to use network. They have successfully used network to carry out trade activity.

(4) It has had an inkling of the matter for sole product market to use network, such as books, clothes and white sugar.

## 2. The Tendency of EB in China

There were two bugle calls of EC in 2000, which aroused enterprises to seek existence and development, and promote competition in market.

### 2.1 Two Bugle Calls and Their Function

(1) According to the message of China Information Industry Ministry, 《The Developing Framework of EB in China》 has been issued in this spring, which directly promoted state-owned large and medium-sized enterprises to develop EB. According to the report of China High and New Technology Industry News, there will be 520 state-owned large and medium-sized enterprises to suif during this year, and they will get the supports of policy and capital from NCET and IIM. That is the first bugle call.

(2) That China joined in the World Trade Organization accelerated the application of EB in state-owned and private enterprises. Because state-owned enterprises are mainly influenced by government, and private enterprises are mainly influenced by market, they will have apparent difference in using EB. The difference will be shown in Table1.

Table1: Difference of using EC in state-owned and private enterprises

enterprises of different categories	necessity	probability	flexibility	timeliness	effectiveness
state-owned enterprises (especially for large and medium-sized)	weak	strong	weak	late	worse
private enterprises	strong	weak	strong	early	better

From table1, we can got following conclusion. Under the common conditions, state-owned enterprises have such good basic situation as credit, organization, management and technicians in using EB; at the same time, they still have some disadvantageous factors. But if some concerned ministry and committee provides capital and policy assistance as they promised, it will be likely to form a high tide to use EB in state-owned enterprises during a short period.

### 2.2 A Little Tide in EC of China in 2002

#### 2.2.1 The Overall Framework Has Initially Formed

From the above, we can see that the external environment of EB in China has made great progress during the past resent years. Because of national policy and international trade, the application of EB in China promoted by internal power and external pressure will probably raise a little tide. The pattern is shown as Figure1.

### 2.2.2 The Figure Above Displays The Function Of Each Subsystem

Above all, government sub-network will play roles of guidance, management and demonstration to circulation, production and consumption sub network. Secondly, IT sub-network will provide technical platform, safe technique and leading applying. Thirdly, bank sub-network will play the role of payment, intermediary and combined settling accounts. Finally, science and education sub-network will play the role of training talent, transmitting knowledge and cultivating technique.[3]

### 2.2.3 The Number of State-owned Enterprises Using EB Will Break Through

Under the guidance and support of government, EB will be widely used in state-owned enterprises.

### 2.2.4 Private Enterprises Will Fully Display Their Talents in Using EC

Since 2000, such websites as sohu, sina, 8848 and 3721 have revealed the strength out of the ordinary.

### 2.2.5 The Diversify of EB Will Begin to Show Ability or Talent

During the past, people mainly talked about B (business) TOB, BTOC (consumer), therefore there will increase G (government) TOB, GTOC, U (university) TOB, UTOC and CTOC (EB among consumers) during the new developing tendency.[4]

### 2.2.6 Production and Trade Suif As A Single Spark Can Start A Prairie Fire

A lot of single variety and trade websites are actively preparing for carrying out marketing and trade on network, like automobile, iron and steel, coal, furniture, building materials etc.

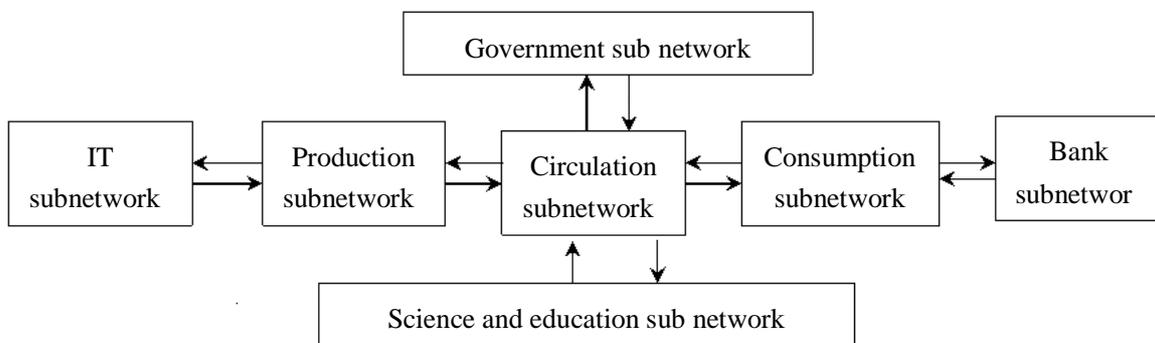


Figure1: the pattern of EB

### 2.3 Traders Will Be The Main Force of EB.

According to analysis and forecast, there will be four stages in the development of EB in China. They are technique promotion, knowledge spread, law and regulations manufacture construction and enterprises application. Although we can't say we have had good development of the former stages till today, due to the comprehensive promotion of domestic and alien, EB in our country will partly step into the fourth stage this year, and will form apparent symbol and characteristics. That is there will be many trader using EB and suif in EB.

## 3. The Applied Countermeasure of EB in China

As far as the subject of EB is concerned, we can discuss our countermeasure of EB under new condition from four aspects: Government, Trade, Enterprise and School.

### 3.1 Governmental Countermeasure

As director, manager and demonstrator of EB, government should act well as follows:

#### 3.1.1 Planning Construction of EB

It is the most important task in this field for government to construct the national EB from its framework of developing strategy to nationwide and district EB.

#### 3.1.2 Law Construction of EB

Law construction can start with market management rules and constantly summarize experience and lessons, then transfer to paralaw and formal law.

#### 3.1.3 Standard Construction of EB

It revolves many aspects of manufacture and construction such as standard of information technology, standard of safe, standard of trademark code and standard of commercial process.

#### 3.1.4 Stressing Exemplary Engineering

The National Development of Information Industry paid special attention to eleven exemplary engineering in 2000, and achieved good results on the whole. We should summarize and communicate experience on this basis so as to play its exemplary role.

### 3.1.5 Governmental Application

It is the principal application of governmental EB to invite tenders, purchase, pay and settle accounts through network, which will play its active guiding and exemplary role, and achieve immense social and economic benefit.

## 3.2 Trade Countermeasure

Responsible departments of the trade and society in our country share the guiding role of trade action. In the development of trade EB, we can consider taking some countermeasures as follows:

### 3.2.1 Sole Product Suif

We can choose important merchandise to market by sole product suif in a trade. For example, in 1999, National Committee of Economy and Trade convened a conference—"the EB conference of wholesale trade" in Guangxi province and introduced the suif of manufacturers of sugar with osmanthus flowers and some other commodities. This year, there will be more sole products to be put into market by suif. As is known, National Trade Department has ratified the trade suif project of Chinese automobile.

### 3.2.2 Trade Suif

Many specialized trades are brewing suif project one after another. Our country's "San Jin", "Shi Jin" and Property Tax, Finance and Trade all fall into this category.[5]

### 3.2.3 Comprehensive Commercial Network

Our country has progressively opened comprehensive commercial network from 163 and 169 to every department of local information through using the experience of California's commercial network.

## 3.3 Enterprise Countermeasure

The development of our enterprise's EB can consider following principles:

### 3.3.1 Deepen Understanding, Work Out Plans, Strengthen Management and Follow in Order and Advance Step By Step

First, enterprise's policymakers, management and core members of business, buying and selling members should accept training by stages and in groups to deepen understanding, strengthen knowledge and technological skills. Second, according to its own condition, an enterprise should work out good development planning of applying EB. Third, adhere to the objective request of EB to strengthen management and play its active role from

laws and regulations to technology, from system to staff, from static state to dynamic state and so on. Finally, an enterprise can do well from the outside to the inside, from the easy to the difficult, from the single to the diversity, from the marketing through network to the trade through network and carry out its own strategic plan comprehensively.

### 3.3.2 Pay Attention to the Strategic Style

According to large and medium-sized enterprises and medium and little-sized enterprises, we may use different process of entering and developing. The main differences are the style from outside to inside—to drive enterprise's EB and information by market EB, the style from inside to outside—to associate outside market EB by inside information of enterprise, the style laying equal stress on both inside and outside—to emphasize enterprise's information and EB on the one hand, and on the other hand, to emphasize introduce and link of market EB.

### 3.3.3 Organize Elaborately

It can be divided into several levels of economic and technological combination from the most simple suif of single machine to browse commerce information to open special website to engage in trade. All these tries to let efficient VS price and benefit VS price both be good.

## 3.4 Countermeasure of College and University's Science Research and Talent's Training

According to the experience of developed countries and our own national conditions, the countermeasures of college and university's science research of EB and talent's training contain the following aspects:

### 3.4.1 The Theoretic and Applied Research of EB

Science research of college and university should trace the practice of EB at home and abroad, and constantly summarize practical experience to form theories and check, rectify, develop these theories in practice, then proceed to guide practice to become the knowledge and talent treasure-house of government, enterprise and society.

### 3.4.2 Special Persons' Training

Open special courses of EB in present majors such as Marketing, Management of Enterprise, International Trade and Trading Economy.

### 3.4.3 To Open Major of EB after Receiving The Approval Of The National Department In Charge

3.4.4 Some Majors Such as Information Technology and Commercial Management Combined Open Double Degrees of EB

3.4.5 Develop International Cooperation, and Train Compound Senior Talent of EB (mainly refers to postgraduate and over levels)

#### 4. Conclusions

EB of China will set off a high tide in 21st century. It is necessary for government, enterprise, college and research organization to make effort, meet new challenges and obtain good repayment in the meantime.

#### References

- [1] Ding Li, Foundation of EB, Beijing: Capital Economy University Press, 1999.
- [2] Junfa Ding & Xuchang Zhang, Developing Strategy of Circulation in China of Going beyond the Century, Beijing: China people's University Press, 1998.
- [3] Lixin Yao, Perspective of EB, Beijing: Economy and Management Press, 1999.
- [4] Qi Li, EB of China, Xi' an: Southwestern Finance University Press, 1997.
- [5] Xiang Guan & Qiong Qin etc, EB and its practice in China, Beijing: Tsinghua University Press, 2000.

# A SMIL- Based Catalog Presentation System in Electronic Commerce

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## Abstract

Web-based catalog presentations play the key-enabling role in E-commerce in recent years. Existing catalog systems often acquire proprietary platforms, cannot deal with TV-like media objects, or consume network bandwidth inefficiently. With the emergence of advanced technologies of Web and multimedia, such hurdles can be removed. The Synchronized Multimedia Integration Language (SMIL), proposed by W3C allows Web designers to design complicated and vivid multimedia presentations in a declarative manner. These presentations are then rendered on a general-purpose browser by a SMIL player. Since the SMIL specification is quite new to the Internet and E-commerce societies, the functionality and applications of players is limited. In this paper, we propose a novel architecture based on Java JMF technology for tackling with such constraints. The effectiveness of the proposed system is validated through an experiment on product catalog presentations.

Keywords: Electronic commerce, electronic catalog, XML, SMIL, multimedia presentation, Java

## 1. Introduction

The advent of the Internet has given birth to Electronic Commerce (EC). In the short space of ten years, EC has shaped a new type of business world; it has greatly affected operations between business (B2B) and changed transaction channels between business and individuals (B2C). In general, effect of the Internet on commercial activity can be characterized by the three well-known facts. Firstly, it is the shifting of power from sellers to buyers through the reduction of the cost of switching and the free distribution of a huge amount of price and product information. Secondly, it is the stimulation of economic activity through the reduction of transaction costs. Lastly, it is the creation of new commercial opportunities through low cost of distributing and capturing of information, which is carried out with a speed and wide range that has never been seen before. This coincides with the study in [20], which identifies two major EC applications: product catalog which provides the information about the product and transaction

management which manages the order interactions. The first application is of particular importance since it behaves as the interface between customers and vendors. In the competitive EC environment, vendors race for consumer's "click-shopping" in one minute.

To gain the competitive edge, vendors must keep the catalog vivid, useful, informative, and interactive. In addition, the catalog contents should be designed and maintained in an efficient way. For this, multimedia, the other major enabler driving EC comes in. [1] [2] [6] [13]. In general, multimedia refers to the integration of time-based media such as audio and video and static media such as text, still images and animated images. With the convergence of the Internet and multimedia, organizations can gain a competitive edge from improving business performance [6]. Gunasekaran and Love recently proposed a framework for the design of multimedia systems in supporting numerous business applications and point out several future research directions. Puri et. al. investigated how multimedia integration enhance EC. Yen and Ng reviewed and discussed some web-based catalogs, categorized by five layers: application, presentation, organization, function, and physical form [20]. They also implemented a web-based catalog prototype in a 3D Virtual Reality Modeling Language (VRML) for mass customization of products in EC. Ehrke proposed a web-based catalog using Java technology to present car stereos to customers [4]. Shim et. al. proposed a Synchronized Multimedia Integrated Language (SMIL)-based catalog system accompanied by a presentation player written in Java [16]. For the system surveyed, the media used in presenting catalog contents ranges from text, to HTML, to 2D/3D object, and to video clips. However, there are three major shortcomings existing in these systems. Firstly, they fail to provide TV-like live catalogs. Without doubt, TV is the most efficient channel for delivering product information in spite of the Internet era. Secondly, the presentation contents are delivered mostly in a point-to-point (unicast) way so that the network bandwidth is obstructed. Finally, some of the systems violated the principal of architecture neutrality so a proprietary platform is required for running the catalog presentation.

The objective of this research is to develop a catalog presentation system for supporting EC that can effectively

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overcome these three hurdles. We rely on our previous work in multimedia streaming [10] and the SMIL standard, building on XML, proposed by W3C provides a simple way to design multimedia presentations in a similar manner to HTML documents. Section 2 presents the information technologies that are needed in the development process. Related work in designing SMIL players is discussed in Section 3. The system architecture of the proposed Web-based SMIL player is described in Section 4. Section 5 is system demonstrations. Section 6 concludes the paper and discusses some future work.

## 2. XML, SMIL, and JMF

A SMIL player is essentially a Web-based application, which is software-intensive system and thus needs seamless integration of the emerging Web computing technology – Java and XML. Java is well recognized for its architecture neutrality, and well accepted as a vehicle for building enterprisewide information systems. XML is designed for document neutrality that can facilitate universal message exchange. Java works well in a distributed environment, allowing users and programs to share information easily, while XML provides a tool for distributing and sorting that information. In this section, we briefly review the technologies used in the study

### 2.1 XML

XML (Extensible Markup Language), developed in 1997 by W3C, is an enabling technology for facilitating vendor-neutral data exchange [3]. Similar to HTML, XML is a metadata language for defining markup languages such as SMIL, MathML (Mathematical Markup Language), and CML (Chemical Markup Language). In contrast to HTML, which describes the presentation layout of a document in a Web page, XML specifies the semantics and structure of the document. XML differs from HTML in three key concepts, namely extensibility, structure, and validation [3]. In extensibility, XML allows authors to define new tags and attributes for specifying the syntax and semantics of data. In structure, XML supports nested document structures similar to regular expressions. In validation, XML allows a document to be validated via DTD (document type declaration) specification, which identifies what elements are allowed in a document, the sequence of these elements, and element attributes, etc.

XML can be seamlessly integrated with Web in a variety of ways. The most often cited one is its ability in facilitating data exchange between heterogeneous databases due to its vendor-neutrality. It can also cooperate with some kind of style sheets such as XSL (eXtensible Stylesheet Language) or CSS (Cascading Style Sheet), a language for specifying the presentation semantics of an XML document. As a result, XML allows a document to be rendered in different format to support personalized presentation. Other interesting

applications include intelligent search engine, smart agents, and so on.

The elements and attributes in an XML document are extracted by a parser, which can be tree-based or event-based APIs. A tree-based parser builds an internal tree structure to be traversed by an application whereas an event-based parser uses callbacks according to parsing events such as the start and end of elements. Each has its advantages and disadvantages.

### 2.2 SMIL

The synchronized multimedia integration language (SMIL), developed by the Synchronized Multimedia (SYMM) Working Group of World Wide Web Consortium (W3C) in 1998, provides a simple way for designing TV-like multimedia presentations on the Web [8] [15]. The syntax of SMIL conforms to the XML standard so that one can write SMIL presentations using general text editors. There are several salient features making SMIL attractive in design Web-based multimedia presentations. Firstly, the presentation designer can indicate the spatial layout and temporal relationships of media objects of text, audio, video, image or any other media type; where and when the objects are shown. For spatiality, it differs from the text-based HTML document which follows one-dimension textual flow style on the screen, instead, SMIL uses a two-dimension layout model without scroll bars and resizing functionality [8]. For temporality, SMIL defines a set of timing constructs to synchronize a group of media objects sequentially or in parallel and to specify their begin, end, and duration times. Secondly, media objects can be distributed either from the same resource of the SMIL document or any place specified by uniform resource locator (URL) such as HTTP, FTP, or RTSP. Thirdly, a set of navigation constructs is also defined to support the functionality of HTML-style hyperlinks. Finally, media objects can be presented on client's browsers according to system and personal preferences such as network bandwidth, user language, and screen resolution.

SMIL presentations are rendered on Web browsers by a SMIL player. Existing popular players for SMIL 1.0 includes Microsoft Internet Explorer 5.0, Apple QuickTime 4.15, RealNetworks Realplayer 8, Helio SOJA [17], and CWI GriNs [5]. Most of them except SOJA can only run on proprietary platforms such as Microsoft Windows or Macintosh; this limit their usability. However, achieving smooth SMIL video presentation over the Internet is a non-trivial work which involves prefetching and buffering media objects [7].

### 2.3 Java Media Framework (JMF)

The JMF API provides three packages: Player, Capture and Conference for manipulating time-based media including playback, capture and conferencing [9]. It supports most standard media content types such as AU, WAV, MIDI, MPEG-1, and QuickTime, and AVI. There

are two JMF versions available currently: JMF1.0 (designed for playback and JMF2.0ea (early access), in which the functionality of media capture is added. With Java Media Player, developers can design media players receiving and presenting either from reliable sources such as a local (via FILE) or network (via HTTP) file or streaming sources including broadcast media, multicast media, and VOD. JMF1.1FCS supports RTP for playing broadcast and multicast media for limited media types including DVI, GSM, G723, and G711 except MPEG-1. Although JMF2.0ea improves MPEG-1 in which Layer 1&2&3 (MP3) is also supported, MPEG-1 video is still not provided. Therefore, it is a great challenge for playing RTP multicast MPEG-1 using JMF.

The JMF mechanism is a layered architecture. The data source layer is in charge of data acquisition whereas the processor layer takes care of data un-compression and passing data to renders such as monitor or sound card for presentation. There are two classes in the data source layer, namely PullDataSource and PushDataSource, in which the former is designed for local-file (including MPEG) streaming play and the latter is for networked non-MPEG streaming play via RTP. These two classes are totally different and may not be cast to each other straightly.

### 3. Related Work in SMIL Players

SMIL players available on the Internet can be generally grouped as two categories based on the environment they run: proprietary and Java-based. An up-to-date list can be found in [19]. We briefly review several major players in this section.

The first category includes Microsoft IE, RealPlayer, and GRiNS. To improve multimedia and interactivity in Web pages, Microsoft IE5.5 offers a set of attributes in the so-called HTML+TIME construct for specifying the timing behavior of media objects such as start, end, duration and repeat times [18]. HTML+TIME is implementation of the HTML+SMIL profile in SMIL 2.0, which is currently in the stage of working draft. RealPlayer from RealNetworks supports playing SMIL presentations since its G2 version in 1998 [14]. RealPlayer G2 was the first SMIL player implementation in the key vendors of networked multimedia. GRiNs (GRaphical iNterface for Smil) is another presentation system for SMIL documents along with a powerful authoring environment [5].

The second category which adopts the Java approach includes S2M2 (Streaming Synchronized MultiMedia) [11], SOJA (Smil Output in Java Applet) [17], and the JavaBeans approach [16]. Both rely on old version of JMF technology however SOJA fails to play mpeg items and S2M2 did not support streaming media objects using Realtime Transport Protocol (RTP).

## 4. The Proposed System

We utilize the Java computing and JMF technologies to develop the SMIL presentation system to meet two goals, namely RTP streaming and navigation of HTML-style hyperlinks. This section discusses our system development approach. The high-level system architecture is illustrated in Figure 1.

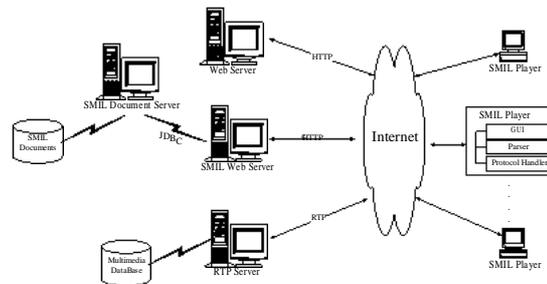


Figure 1. The system architecture

It contains Web Server, SMIL Web Server, SMIL Document Server, RTP Server, Multimedia Database containing MPEG and MP3 items, and SMIL Player on the client side. The platform where each component runs can be different. The Web Server acts as an object repository for downloading the SMIL Player applet to eliminate the need for installing the component. Thus, the Web Server shows emergent Object Web of the evolving client/server model [12]. The player contains three major components. The GUI component allows customers to retrieve catalog presentations in SMIL documents, managed by the SMIL Document Server. The Parser component, which is a SAX (Simple Api for XML)-compliant parser, a event-based parser, validates the specified SMIL document and retrieves the embedded elements and attributes. The Protocol Handler invokes the procedures for handling specific protocols such as RTP MPEG or HTTP/HTML. For the request of RTP MPEG streams, the client sends a subscription request to a multicast group for receiving contiguously transmitted demultiplexing RTP video/audio streams from RTP Server (see Figure 2).

Raw video/audio data are then fed into buffers for efficiency consideration when playing. Depacketization and Video/Audio Buffer constitutes Video/Audio Data Source which inherits from the class PullDataSource defined in JMF so JMF Player can treat video/audio raw data as coming from reliable data sources such as FILE or HTTP. Finally, the depacketized raw data in the buffer must be converted into bit streams for playing using JMF Player.

Figure 3 illustrates the sequence diagram in UML (Unified Modeling Language) for rendering RTP MPEG streams.

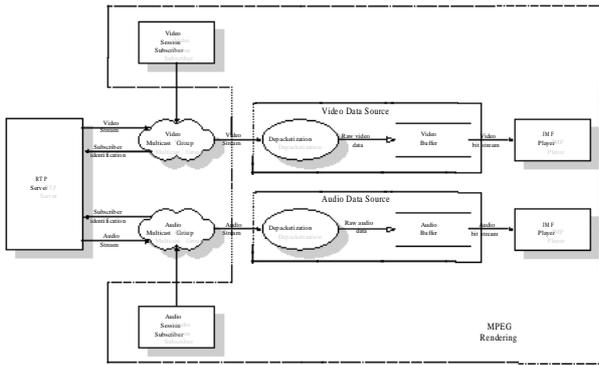


Figure 2. Rendering RTP-MPEG presentations

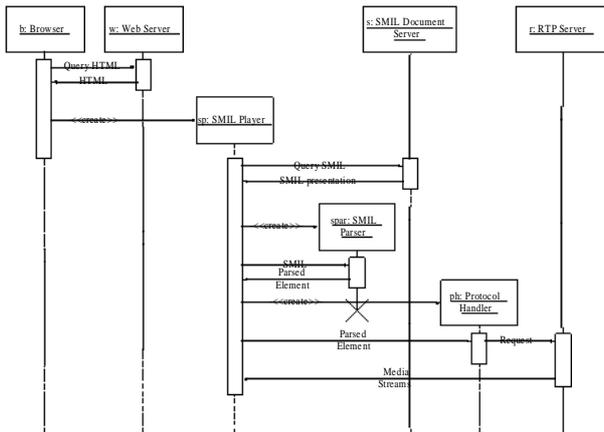


Figure 3. The sequence diagram of the SMIL player

Customers log into the catalog system via a Java-enabled browser to download the SMIL player in the applet form and create it as a player object in Java Virtual Machine (JVM) in the browser. After the customer chooses the product of interest, the player in turn contacts the SMIL document server to obtain the SMIL presentation for the product. This document is parsed and the embedded media objects are retrieved from remote multimedia databases. Finally, the protocol handler invokes the RTP render to communicate with the RTP server and renders the video and audio streams received.

### 5. System Experiments

The proposed system has been experimented on the NKFUST campus network environment for supporting a virtual EC portal site. We discuss the cases of navigation and RTP-MPEG streams in this section. Figure 4 shows the SMIL presentation document for Cisco's IP/TV product. It indicates the layout about the three synchronous media objects (one RTP-MPEG, one local HTML and one remote HTML items). It is worth noting that a subtle syntax provided by SMIL when designing a catalog presentation.

Figure 5 is the snapshot during the presentation is rendering. On the right-hand side of the panel, one can navigate the Web page as in a HTML browser when watching RTP-MPEG streams as shown in left-top screen.

The text window on the bottom provides the functionality of text caption. This greatly improves the interactivity of the presentation. Thus, the proposed system meets the requirements of spatiality, temporality, and interactivity for multimedia presentations.

```
<smil>
<head>
<layout>
<root-layout width="640" height="420" background-color="white" />
<region id="video_panel" left="10" top="20" width="370" height="263" />
<region id="html_panel1" left="390" top="20" width="240" height="390" />
<region id="html_panel2" left="10" top="300" width="370" height="180" />
</layout>
</head>
<body>
<par>
<rtsp video="rtsp://224.123.111.101:22224"
audio="rtsp://224.123.111.101:22225" region="video_panel" />
<html src="http://www.cisco.com" region="html_panel1" />
<html src="file:d:/project/cisco.htm" region="html_panel2" />
</par>
</body>
</smil>
```

Figure 4. The experimental SMIL presentation

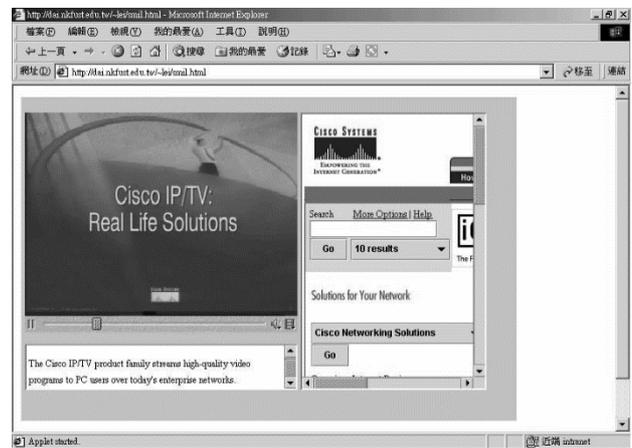


Figure 5. The rendering result of the SMIL presentation in Figure 4.

### 6. Conclusions and Future Work

The work presented in this paper was motivated by the need for the development of Web-based catalog presentation system in EC. We surveyed existing systems and identified three pitfalls in existing systems, namely violating platform neutrality, inefficiency in network bandwidth, and the lack of live TV-like presentation quality. In this paper, we followed the SMIL standard in multimedia presentation and applied the emerging Java distributed multimedia computing technology to alleviate such weaknesses. The system proposed in this paper is a novel architecture for playing live TV-like SMIL. In addition, the navigation of HTML-style hyperlinks is offered by appealing to the Java Swing facility. To meet the reusability of software development, we integrate the component of RTP player developed in our previous work and SAX for parsing SMIL documents. The resulting system is at its initial stage but demonstrate an encouraging direction towards EC applications. As far as

the references surveyed, our work presented is the very pioneering study in the literature towards integrating playing RTP media and Java JMF in Web-based catalog presentations. The future work includes the performance evaluation on the network bandwidth and enhancing the system to offer VCR-like functionality for more vivid catalog presentations.

## References

- [1] R. Aaron, M. Decina, and R. Skillen, "Electronic Commerce: Enablers and Implications," *IEEE Communications Magazine*, Vol. 37, No. 9, Sept., pp. 47-52, 1999.
- [2] S. Boll, W. Klas, and U. Westermann, "Multimedia Document Models – Sealed Fate or Setting Out for New Shores?" *IEEE*, 1999.
- [3] "Extensible Markup Language (XML)," <http://www.w3.org/XML>.
- [4] J. Ehrke, "Product Simulation with Java in the Internet," *Procs. of the International Conference on Advance Issues of E-Commerce and Web-Based Information Systems, WECWIS*, pp. 73-74, 1999.
- [5] GriNs, GRaphical iNterface for Smil <http://www.oratrix.com/GriNS/>
- [6] A. Gunasekaran and P.E.D. Love, "Current and Future Directions of Multimedia Technology in Business," *Int'l Journal of Information Management*, Vol. 19, pp. 105-120, 1999,.
- [7] P. Hoschka, "An Introduction to the Synchronized Multimedia Integration Language," *IEEE Multimedia*, Vol. 5, No. 4, pp. 84-88, 1998.
- [8] P. Hoschka (Ed.), "Synchronized Multimedia Integration Language," *World-Wide Web Consortium Recommendation*, June 1998, <http://www.w3.org/TR/REC-smil/>.
- [9] Java JMF homepage: <http://java.sun.com/products/java-media/jmf/>.
- [10] S.-T. Li, T.-S. Li, and S.-W. Chou, "JTViewer: A Java JMF-based Viewer for Real-time TV-like Streams," *International Workshop on Internet in conjunction with The 20th IEEE International Conference on Distributed Computing Systems*, 2000.
- [11] NIST SMIL Project, <http://mpeg4.nist.gov/player/>
- [12] R. Orfali, R. and D. Harkey, *Client/Server Programming with Java and CORBA*, John Wiley & Sons, 1997.
- [13] A. Puri, R. L. Schmidt, Q. Huang, "On Feasibility of MPEG-4 for Multimedia Integration for E-commerce," *IEEE International Conference on Multimedia and Expo.*, Vol. 1, pp.75-9, 2000.
- [14] RealPlayer G2, <http://www.realnworks.com/>
- [15] L. Rutledge, J. Ossenbruggen, L. Hardman, and D. C. A. Bulterman, "Anticipating SMIL 2.0: The Developing Cooperative Infrastructure for Multimedia on the Web," *Computer Networks*, Vol. 31, pp. 1421-1430, 1999.
- [16] S. S. Y. Shim, J. Z. Gao, Y. Wang, "Multimedia Presentation Components in E-commerce," *Second International Workshop on Advanced Issues of E-Commerce and Web-Based Information Systems*, pp. 158-165, 2000.
- [17] SMIL at HELIO, <http://www.helio.org/products/smil/>
- [18] "Spice Up Your Web Pages with TML+TIME," <http://msdn.microsoft.com/workshop/Author/behaviors/htmltime.asp>
- [19] "Synchronized Multimedia," <http://www.w3.org/AudioVideo/>
- [20] B. P.-C. Yen and K. Y. M. Ng, "Web-based Virtual Reality Catalog in Electronic Commerce," *Procs. of the 33rd Hawaii International Conference on System Sciences*, 2000.

# Influences of New Trend in Development of American and Canadian E-Business upon Mainland Enterprises and Our Development Strategies

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## Abstract

A comprehensive view of the world E-business development in the past year shows that, in spite of the turndown of the net economy for the past year and that the term "E-business" is even used by many media to represent "Foam Economy". But within some high-tech companies as well as some conventional industries under reconstruction, "Mouse Plus Concrete", another model of E-business, is now showing brand new value. Meanwhile, some conventional enterprises in the mainland are also brewing further breakthroughs in E-business in order to take the win of the coming market competition. As for the conversion of the enterprises, the model of E-business in North American countries like USA and Canada is undoubtedly the example and forerunner for domestic enterprises. In this background, the article, via a research of new situation of E-business development in North America as well as typical cases of its application in the enterprise, is intended to analyze and sum up the application characteristics and accordingly, the pressing demand for E-business as well as reasoning and measures of E-business development in enterprises.

## 1. Introduction

In March of 2002, as a member of the Exploratory Mission of Electromechanical Chamber of Commerce Enterprise Information and E-B, which was initiated by International E-B Department of Foreign Economic and Trade Ministry and China Electromechanical Products Import and Export Chamber of Commerce, the author did research work and exchange activities with IT enterprises and academic research institutes both in America and Canada. In particular, the author researched on 11 companies such as Oracle, Dell, CommerceOne, Broadvision, etc and underwent training and discussion in Austin School of Texas University upon Internet economy, E-B and electronic purchasing.

## 2. General situation of E-B development in USA and Canada

2.1 The scale of business activities (B2B) via Internet between enterprises in USA and Canada keeps increasing, which includes the following activities through Internet.

2.1.1 Coordination upon purchasing between the enterprise and the supplier.

2.1.2 Business coordination between procurement planner and warehousing and shipping companies.

2.1.3 Coordination between sales branches and wholesalers as well as retailers of their products.

2.1.4 Customer services.

2.1.5 Daily operation of the enterprise and exchange between employees in the enterprise.

2.2 The area of B2C keeps expanding, which is prominent in sales of invisible goods and service products, such as computer software, consumption of entertainment products, tickets booking, payment and information services etc. The products and services, with no need of any material form or special packaging, are transferred to the customer via Internet as electronic version, which represents the advantage of Internet sales with a strong vitality.

2.3 The trend of increase of material goods is furtherly quickened, mainly including

2.3.1 The range of products sales via Internet is expanding gradually. One or two years ago, most people bought only computer software or hardware or books on the Internet, and now it has come to all kinds of goods. Apart from standardized brand products which are accepted generally with the form of Internet sales, more and more garment, medicine, food, toys, drinks, shoes, furniture and other daily household products are put on Internet for sales and a lot of new net-shops spring like mushrooms.

2.3.2 Many conventional manufacturers and industries have established websites of their own, offering directly to their customer sales business and services. In particular, sales via Internet have shown strong competitiveness and expansion in industries like computer and car sales. What's more, to confront better with new competition, various business organizations, including famous retailers and wholesalers are establishing net-shops of their own. Especially some big retailers and wholesalers like WAL-MART, TARGET, SEARS, etc make full use of their existing brands to expand quickly Internet business as a combination of Internet sales and conventional shop sales with good results.

2.4 The E-B level of conventional industries is increasing and achieving exciting effects.

During transformation process of conventional enterprises to Internet economy, high-tech companies like

DELL, CISCO, GE, etc have achieved investment yield rate of over 250% with sale per capita as over USD650,000. After realization of Internet purchase in other conventional enterprises, procurement cost has decreased about 30% in WAL-MART, 45% in TARGET, 33% in Toy R Us. And with the employment of supply chain management technology, turnover during one year in TRACE NET has increased by 392 times, making the enterprise boom from a regional pet food supplier to a global network chain supply group of toys, garment and pet articles.

2.5 Making use of the opportunities provided by Internet economy and strengthening brand new competitiveness of the enterprise has become the mainstream of E-B in enterprises at present.

Since what the Internet economy has changed is far from a change of concepts or operating channels, the main body of E-B is a challenge to be confronted by the whole economy and all trades.

### 3. The influences of development of E-B upon development of the enterprise

Guonashi, the former president of IBM, has depicted the influences of E-B upon enterprises by pointing out that, in the case of ever-increasing of market share of Internet economy, only when the company masters operation rules of E-B market and is able to make better use of E-B techniques in specific operation of business development, can it possess space of survival and development. While world-class companies take the force of Internet and make use of it for transformation of their own, the real storm of Internet economy has been formed.

After research on companies like IBM, Oracle, Dell, CommerceOne, Broadvision, EDS, etc, we come to realize that the development of E-B has created more market growth space, while in realization process of E-B in the enterprise, the aim of the enterprise is more the achievement of increase and development of business through optimization of sales process, decrease of cost and improvement of service individualization. For example, Oracle, as the second biggest software manufacturers in the world, has achieved a sales volume of USD11,000,000,000. While the employment of Internet E-B solution project of its own saved an annual of USD1,000,000,000. of daily operation expenses, which is equal to an increase of 10% of annual profit margin. While the employment of global E-mail system has saved USD30,000,000 and the effects of the whole technology globalization is a saving of USD200,000,000 of operation expenses in global sales system. At the same time, over 50% of direct sales on the Internet have made DELL as the eventual "King of Direct Sales" and "King of Low Prices" in international PC circle and hold the first place among PC and SERVER manufacturers home and abroad from the first quarter of 2001 till at present.

In conventional industries, E-B is now more and more positive influences.

Boeing gets simultaneous visits from 38,000 persons all around the world via Internet system, which achieves an accuracy of 100% for BOM (Bill of Materials), a decrease of average revision times of each order to zero from 17, a decline of average circulating time of the order subject to internal audit from 25-30 days to 6-10 days, a drop of a series of sophisticated product data systems from 30 to 1, an increase of material velocity from 4.5 to 9 while a drop of total unit cost of 80%.

US Airlines has established individualized services to its customers via BROADVISION system on the Internet. Through a series of adjustment and alteration, the volume of tickets booked through Internet by US Airlines Website has increased by 6 times than before. Tickets booked via Internet thus have become one of the major income sources for US Airlines.

It can thus be seen that among the three themes of the current world development, i.e., information economy, globalization and sustained development, information economy with Internet economy as major instrument and carrier is the strong force to push development of productivity. The development of Internet economy undoubtedly promotes the process of globalization, while through development of E-B in the enterprise, making use of network and electronic instruments for realization of net virtual operation, expedition of business process, decrease of operation cost, establishment of a closer relation with trading partners and guarantee of "win-win" situation in business process and competition process is the key of sustained development of the enterprise, the most important influence by E-B upon the enterprise and the most important aim of the enterprise to develop E-B.

### 4. Major characteristics of E-B in North America and consideration of E-B development in domestic enterprises in China

Through the aforesaid analysis, we think that several major characteristics of E-B development in North American enterprises are in particular worth our thorough researching and practicing combined with domestic situation.

4.1 With electronic network as media of sales network, limits of conventional sales network have been broken to provide the enterprise an easier approach to the market and the customers for supply of individualized services. Global sales system of ORACLE runs through every stage like supplier, customer, booking, store, distribution etc. Through close combination of on-line supply chain management system and customer management system, effective expansion of new markets and on-line tracing and analyzing have been realized to provide to the enterprise a better idea of distribution and predicted

distribution, to make the relevant service series development and change of Internet economy surely will be defined by the customer and to increase the customer's satisfaction and loyalty. Global purchasing system, which is similar to Internet competitive bidding, guarantees sourcing world-wide with low prices and good quality as well as low prices of finished-products and good profit of the enterprise.

4.2 Reformation and conformity of sales process via E-B system assure optimized management of supply chain and optimized allocation of resources. The successful adjustment of internal processes assures DELL products the shortening of parts and fittings purchasing and store management in the supply chain, shortening of distribution stage in sales process and continuous keeping of low cost operation. As it can be seen in PC assembly factory, all the parts and fittings of DELL are stored in warehouses of its manufacturers. The order got by DELL from the customer is at the same time divided into small orders to its manufacturers, who send the parts and fittings as required to assembly factories to assembly finished products subject to sales. Last year, DELL also set up the on-line purchasing system ACCESS for most of its suppliers, thus the suppliers can have a good idea of most up-to-date information regarding store and sales in DELL, an earlier knowledge both for DELL and for the suppliers of possible shortage of parts and fittings and production can be arranged accordingly to avoid overproduction or overtime production with high cost.

4.3 Through employment of E-B measures a further increase of dealing and management proficiency is achieved and at the same time dealing and management cost in business process is lowered. On-line direct sales model based on Internet Ordering System and Customer Service Center has made average store time of DELL decrease, calculated in hours, if the control standards in the enterprise are 4 hours for desk PCs and 8 hours for servers, that means every week when the new product is supplied by DELL to its customer, its cost decreases by 1 time. The low-cost operation brought for DELL an increase of 44% solely in 2001, while during the same year the increase rate for Compaq was only 1%.

4.4 The on-line analyzing system guarantees expedition of, accuracy and scientific decisions in business information. DELL recently has adopted a Cost Pre-estimation System to support its flexible pricing strategy, according to which its 25 major suppliers for parts and fittings and other suppliers shall supply as per schedule the up-to-date cost and price information for DELL to pre-estimate the price for each part or fitting in the following months. Due to strict cost control and flexible pricing, the sale of DELL in the whole year of 2001 reached USD33,000,000,000, leaving its old competitors such as IBM, HP and COMPAQ far behind.

As can be seen from analysis of competition situation among domestic enterprises at present, the quick

bring major shocks to management framework, business model, distribution channel and development strategy in conventional enterprises and thus many new conflicts will appear. Whereas with China's entry into WTO, the enterprises are now confronting a brand new adjustment of strategic pattern and transformation of part of their business. Transformation of this kind appears to be quite difficult to start in state-run enterprises. Taking this aspect into consideration combined with developing trend for international E-B, we think that the track for E-B development in domestic enterprises can be considered of in the following three aspects.

Firstly, making full use of characteristics like continuous increase of business groups on the current Internet with combination of resource advantage of the enterprise, extensive information and ever-increasing business channels, the "Mouse Plus Concrete" model shall be applied to establish Internet virtual enterprise with Enterprise Resource Plan (ERP) System, Supply Chain Management (SCM) System and Customer Relation Management (CRM) System, to increase operation level of conventional business with modern scientific and technical methods, at the same time to accumulate practical experiences of E-B and to nurture talents familiar with operation under Internet economic situation. This is our first of E-B practice.

Secondly, according to the development strategy of the enterprise and requirements of E-B development, integration and exchange interface for information inside and outside of the enterprise shall be constructed through practices of website popularization and network construction of the enterprise. The development of E-B towards a deeper level shall be promoted through development of Internet strategic alliance and closer coordination with business partners.

Thirdly, with the government or guild as the go-between, the experimental unit or organization shall be chosen for E-B development of the enterprise. The best shall be the focus of development and subject to active popularization. Bold exploration shall be made in practices of Internet operation as leaders and forerunners.

## 5. Strategies and measures taken by mainland enterprises in further development of E-B.

5.1 The knowledge of enterprises to E-B should be increased with standardization of enterprise core business process and construction of ERP system as key of E-B development of enterprises.

The entity of E-B is the business activity. Making the use of E-information and network is the method of actualization of business activity. An enterprise is the main body of E-B activity. Through related solid evidence analysis, we consider that on the competitive platform of global market through the internet, it enlarges the advantage and inferior position ruthlessly, the good is

better, the bad is worse. In the same time, network rivals, the enterprise is not restricted in the district area; it faces the un-present global virtual network. The client admits you or not just at the moment. "The fast fish eats the slow one" and "the scope is enlarged by speed" are also the game regulation of new economic era.

So to improve the enterprises' cognition of the importance of E-B development, pay attention to the advanced experience of large enterprises' E-B development in the main targets of America, Canada and Europe. According to the requirement of market competition to regulate the internal operating mechanism of the enterprise, apply the core of information technology of internet to the business activity and enterprise's resource management. According to the international advanced management thought and international standard to regulate the external and internal business circuit, and through the information management system to solidify the circuit and improve the enterprise inner circuit, integrating the enterprise external and internal work circuit and data circuit, enlarge the gaining channel of the enterprise external and internal information and service to decrease the cost of the enterprise operation and increase the work rate, exploit new market space and improve the rate of clients' satisfaction, so as to enforce the marketing competitive ability. We can make the traditional industry earn the driving right in the next competition.

5.2 Special attention should be paid to combination of E-B platform construction and business of the enterprise itself. "Be self-reliant and construct enterprise E-B platform of enterprise" is our major principle in our work henceforth.

Though E-B is universally considered as the main mode of business in 21<sup>st</sup> century, from the China reality, the practical appliance of E-B is a large area needed to be exploited. According to the investigation of Beijing internet development center, at present, only 4.5% China exporting enterprises use the E-B to open business, 31.2% enterprises just at their beginning, still there are 23.6% having no thought of it. It shows that our enterprises' E-B is just at its beginning whether in the aspect of base construction, technical device, operating environment, it has remarkable gap with international advanced level.

From the research of E-Band network extending and marketing of the enterprise in recent years, we profoundly realise that the further development of domestic enterprise E-B first should be based on the connection of the enterprise its own business and the resource state, adopting practical attitude to constitute the E-B development program which fits the requirement of the enterprise itself. During the actualization of the program, from the enterprise itself, regard the enterprise as its largest client to meet the need of its own business. Through the exploitation of CRM, SCM and POL, on the first side improve the communicating method from the enterprise, client to the factory to improve quality of

service, on the other side through the model effect of success, absorb more and more middle and small enterprises around the enterprise through the platform, form E-trading market within the industry, improve the development of enterprise's business. ORACLE and DELL have achieved good results though the mode. "Based on oneself to set up the enterprise E-B platform" is our principle which should be obeyed in the future work.

5.3 The functions of the government, especially its key functions in standardization of market and consummation of laws and rules, should be highly recognized during development of E-B.

During the business revolution of the actualization of E-B, American Government has played a key role in the promotion of the development of E-B. From the four layers of programming, policy guiding, propaganda and training, study and exploitation, American Government promotes the E-B development. In the aspect of programming, American Government announces that the whole national TV system had gradually transferred from analog to digital from 1996 to 2005; in the same time through the law, from 1998, all the expense of the Federal Government Institute should be paid by the electronic method. The former lays a base for the united net of TV, Telephone and Computer; the latter accelerates the development of American national E-B. In the aspect of policy guiding and propaganda and training, in the early nineties, Clinton's Government regarded Information Highway as its administrative program. During the ten years, American Government issued no less than 20 items of law and regulations about E-B. The most influent ones are National Information Base Structure Guideline made by Present Clinton in 1993, Global E-B Schema issued in 1997, and in 1998, Clinton's speech on Network New Policy and draft policy of exemption for E-B, etc.

As the government active promotion and policy supporting and complete set of law and regulations, ten years has passed from 1992 when Clinton provided the imagine of Information Highway in his run for president, American Information Highway has not only started but also achieved great economic and social effect for the America and also for other countries all over the world.

From the analysis on E-B development of present domestic enterprises, the development of E-B is restricted by two levels of factors: one is the appliance extending of Information technology and informatization base and level of internal enterprises; the other is market environment and institution construction. The last restrict is more obvious. From the survey of domestic E-B development in recent years, it is not difficult to find out that the main factor restricting the development of E-B is not the technical problem but the requirement of market environment and institution arrangement. So the key point of government promoting the E-B development is primarily to accelerate the market environment and constitution construction.

In the same time, aiming at the kinds of problems met in the development of E-B, we advise to choose the enterprise which has the representative of the certain industry with good management condition and E-B technical base as an experimental unit. Supported by government special fund, organize special persons to investigate from every link of the management of enterprise supplying chain to find out the common experience which can be extended within the industry. It has important significance to bring along the E-B development of the whole industry.

5.4 Research and establishment shall be done of standards and criteria in E-B industry to guarantee the standardization of enterprise E-B development.

After more than ten years' experience, America and other western countries have formed a set of standard and regulation in E-B transaction, as advertisement of products through network and the XML standard of commodity classification. Now there are few domestic enterprises adopting such a commodity classification. So we should study carefully and are acknowledged about the technical standards (as XML, UBL, etc) adopted by the grand enterprises' E-B system in America and western countries to open the development of the E-B of enterprises. In the same time, under the guide of government or industrial association, adopt the design and classification of network products of authority standard of the interior enterprise to ensure the unified interface with grand network purchasing system of foreign countries, especially of the America and western countries. In the same time, in the course of the practice of enterprise E-B, related government departments and industrial association play a very important role in the

of making and regulation of the product exchange specially, investigating and knowing of the requirements of grand network purchasing system of America and other countries to China supplying software, organizing the technical connection of the suppliers and the purchasers, opening related industrial requirements and E-business standard training class for associating units and all those should be worked out hard at present.

5.5 Exchange and study shall be enhanced with European & American large-scale information enterprises and large-scale department stores as well as chain stores with wide E-procurement for expedited promotion of the development of E-B in mainland enterprises.

We have gained a lot during this survey, seeing with one's eyes today's the whole world fast development in the internet technology and its appliance, increasing our perception knowledge and intensifying our rational knowledge of its development course, environmental condition, practical appliance and the development trend, having acquaintance with American and Canadian information industry development and related products, technology and management actuality, especially for the development of E-B and related social environment. It is important E-B work in enterprise development to make a good technical foundation for the further development of the enterprises though regularly organizing intercommunicate with and learning from the grand information enterprises of Occident and E-purchasing large department stores and chain stores to know the trend of present network economic development and to be familiar with the E-B development environment and technical requirement in Occident.

# Tourism Website Development and User Requirements : Who are Tourism Website Users and What are Their Requirements in China

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## Abstract

China tourism industry is investing to develop a "Golden Tourism Project". One of the main objectives of this project is to improve web-based tourism online service quality and implement tourism e-commerce. In order to develop successfully the project it is necessary to investigate who are main tourism website users, what are their requirements for online tourism services and how do they assess current tourism websites. The main purposes of this study are to identify current tourism website users, analyse user requirements for tourism online services and explore how design tourism websites to attract users, promote tourism landscape points and improve online tourism service quality in China. Through conducting a survey and analysing the survey results, this paper shows the behaviour characters of current tourism website users, discusses their preferences and requirements for online tourism websites, and identifies the major factors that users concern for tourism website construction in China. Components of tourism websites are analyzed and an evolution model for tourism websites in China is proposed.

**Keyword:** Tourism websites, E-commerce, Web assessment, User satisfaction, China

## 1. Introduction

The Internet facilitates various online services, creates more and more virtual products and provides new business transaction models. Tourism e-commerce is one of the fields where Internet is being widely applied in providing online services and products [3] [10]. The development of tourism e-commerce not only changes the tourism marketing models but also results in the changes of the conventional user requirement and conventional measurement of user satisfaction [14] [8]. User satisfaction, which has a great influence on

companies' market behaviour, profitability, and competitive advantage, is a very important factor for a company to establish their market competitive strategies. Hence, tourism website suppliers need to know which types of people are the main users for their websites and receiving their online services, if these users are satisfactory with current online services and which kinds of service functions need to be effectively improved.

Tourism is becoming an important industry sector in China. In 2001, China received 333,200,000 tourists and has become the top fifth tourism destination country in the world [1]. Tourists are becoming more initiative and individually in China. Simultaneously more and more educated young tourists are obtaining tourism information from the web and making various online orderings and bookings. Tourism e-commerce is benefiting tourism companies in reducing costs and reaching a large user group, also benefiting to tourists in making a clear budget and travel plan.

Base on the requirements of National Information Development in China, a current keystone of tourism industry is "Golden Tourism Project". One of the main objectives of this project is to develop tourism e-commerce and improve tourism online service quality. Today web development in China has increased to the point where hundreds of companies are creating new websites and thousands of people are being new users daily. In 2001, more than 12,450,000 computers were connected with Internet in China. There were 33,700,000 people accessing Internet, 6,720,000 of them using broad band, 21,330,000 using dial up, 5,650,000 using both technology, and the rest 1,180,000 using other information equipment and connection [4]. From 1997 to 2000, the number of people to access Internet is doubling every six months, an increasing 20%-30% since 2000 every six month. Simultaneously, user requirement for tourism online service has been increasing. Through few years practice of tourism

online service, it is very necessary for the government and tourism companies to have a clear understanding and identification for current state of tourism e-commerce applications and users' requirements for tourism online services.

There is no any research result for the development and evaluation of tourism websites in China from literature. In the case of website assessment some publications of results exist, such as [5] [7], but there are not addressing tourism websites. Benefits of tourism online service have been demonstrated, such as [12] [11] [2] and [6], but user requirement and satisfaction for tourism website design and online services, particularly in China, are not sufficiently explored.

The initial objective of the research is to provide a picture of tourism website users and their requirements in China. A further objective is to identify a potential path for the development of a customer oriented tourism e-commerce application from its current implementation. This paper therefore focuses on the identification for tourism website users and the analysis for their preferences, requirements and evaluation for tourism websites in China. The research is conducted based on a questionnaire survey. Through data analysis, this research identifies and discusses several important factors of tourism website development including accessing speed, connection expenses, site links, content/interface design and online ordering/shopping. The findings of the project are expected to help the government and tourism website suppliers in China to understand current online user requirements, preferences, satisfaction and behaviours, which will be very benefit for the development of tourism online service. Finally, Components of tourism websites are analyzed and an evolution model for tourism website development in China is proposed.

## 2. Research Method

The study is completed by four main phases: questionnaire design, subject identification, survey conduction and data analysis. In order to obtain the information about the composition of tourism website users and their assessment for tourism website service, a questionnaire was designed to include 20 questions. The questionnaire consists of three parts: part one involves user's personal information; part two involves user's requirement, behaviour and attitude in access tourism websites; part three addresses users' evaluation and suggestions to current tourism website development.

This survey was conducted in several popular Internet cafe clubs in Shijiazhang city and several typical tourism companies. The subjects are Internet cafe club members or registered customers in selected tourism websites. The most Internet cafe club members are experiential Internet users. They usually have high information requirement and have visited many tourism websites in the world. They thus could express more

user requirements to tourism websites and give good suggestions for tourism website design. The registered tourism website users have a long and continued experience in receiving online tourism services. They therefore could give a more fair evaluation and report existing practical problems.

The survey was conducted from 15 to 30 May 2001. Questionnaires were given to subjects by emails or individually handouts (in Internet cafe clubs). Total of 290 questionnaires were sent out and 196 complete responses were obtained. These responses indicated their experience in visiting tourism websites or receiving relevant online services, therefore are recognised as 'tourism website users' in the study.

This study also compares the main findings obtained with the relevant results shown in "China Internet Developing Situation Statistic Report" that is completed in June 1999 by China National Network Information Center (CNNIC).

## 3. Who Are Tourism Website Users

### 3.1 User Occupation Analysis

The survey result shown in Tab. 1 indicates that the main tourism website users are high school/university students (44.8%) and professionals (15.2%). The CNNIC [4] has similar results for general Internet users. CNNIC reported that in 19 main occupations, the biggest proportion is students (19.3%) and computer technicians (14.9%). The two results tell us that students and computer professionals are two main user groups to access Internet and visit tourism websites in China. User occupation is a very important issue to be considered for website suppliers in identifying users' requirements for online services and designing tourism websites.

**Tab. 1 User occupation**

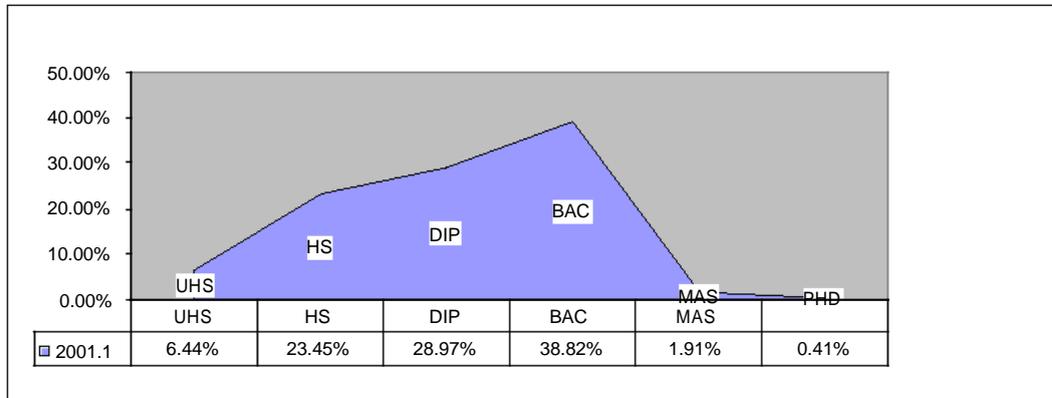
Occupation	%
Civilian	11
Student	44.8
Serviceman	10
Professional	15.2
Manager	7.5
Unemployed	7
Others	4.5

### 3.2 User Education Background

The survey found that most responses have a good education background. There are about 38% of tourism website users has a bachelor degree, and 28% of has a diploma (Fig.1). The result means that the main tourism website users are educated people. The result matches the result of CNNIC [4] which shows that 86% Internet users have diploma, bachelor or above education

background, it is little higher than the result got from the survey. The difference can be explained that Internet use is fast spreading in China during the two years (1999-2001) so that there were more non-high-educated people having become Internet users. This finding also can be explained that more non-high-educated users

have become new users of tourism websites. When more un-high educated people becoming tourism website users, tourism website designers must consider how to match the requirements of all levels of use groups.



PHD—Philosophy of Doctor, MAS—Master, BAC—Bachelor, DIP—Diploma, HS—High School, UHS—Under High School

Fig.1 User education levels

### 3.3 User Age Analysis

Age is also an important factor to determine users' preferences and choices for tourism products and services. The survey shows that about 97.5% of responses are younger than 35 years old and there is no response over 45 years to participate with the survey as an Internet cafe club member or a website register members (Tab.2). This result matches with the relevant results of CNNIC [4]. The result can be explained as that young generation more likes to use Internet as a tool for seeking information and receiving services.

Tab. 2 User age

Age	< 18	18-24	25-34	35-44	>45
%	12.5	65	20	2.5	0

### 3.4 User Income Analysis

Tab. 3 Users' monthly income and Internet accessing cost (yuan RMB)

Monthly income				
Less than 500	500-1000	1000-1500	More than 1500	No income
28%	17%	8.5%	9.5%	37%
Monthly Internet access cost				
Less than 100	200--300	400-600	Not sure	
44%	21%	13%	22%	
Payment type				
Self pay	Business cover			
61%	39%			

As shown in Table 3, most responses have a lower income or no income as most of subjects are students and young people. About 82% of users' income is less than RMB1,000 per month. Only 9.5% of users' income is over than RMB1,500 per month. About 44% of users have a monthly Internet access cost less than RMB100 and 61% of users need to pay their main connection fees by themselves. For such users who do not have strong financial ability and business financial support, the Internet connection/access fees is one of important factors to be considered for access online services

## 4. How Do Users Evaluate Tourism Websites

### 4.1 Accessing Speed and Connection Expenses

The most important factors affecting users' to receive tourism websites are identified in the survey. Responses indicate that the first important factor was "accessing speed", followed by "connection fees", and "service quality" (including information content quality and ease of use). For the question "what are the unsatisfied aspects for current tourism websites", 35% of users mark "speed is too slow". In the question "what are the most important factors for supporting a tourism website success", 40% of responses think it is "high accessing/searching speed". Website accessing speed has become one of the most important factors for users to visit websites and a major problem complained by users in China. The main reasons for having such a lower accessing speed in China are (1) the narrow bandwidth cannot meet the requirement of large information such as photos; (2) there are large amount

of users accessing same data at the same time; and (3) relevant networking technology problems, such as software architecture, search engine algorithms and server output channels, need to be solved. Therefore, the development of tourism websites needs a more effective technical support and regional infrastructure construction.

## 4.2 Search Engine and Relevant Site Links

Search engine is a key function of Internet applications. Installing a search engine to a website will help users to find what they are looking for quickly. In the question “how to know a new website”, about 69% of responses marked “by search engine and site links from existing websites”. In the question “which function is the most frequently used in web service”, search engine is listed with a high rate, following chat room, email and information content. Today’s search engines, such as SOHU, have a fast search speed and wide range of information domain, but lack a clear classification for tourism information. This makes users hard to find what they are looking for. They have to guess a website’ name or key words, and then try various solutions. Integrated tourism websites should define a suitable classification for tourism information and provide tourism packages which combine several tourism components together, such as accommodations, transports and attraction-point information. Particularly they should build enough links to related websites. As some kinds of tourism information, such as transport timetables, are often changed, database is a useful technology for maintaining up-to-date information and allows users to search both static and dynamic information on the websites.

## 4.3 Information Provision

In the responses for the question “what are the main purposes to visit tourism websites”, “to get tourism information” obtains a highest rate. For the question “what is the most popular online service on tourism websites”, “providing information” is listed as the first item. The responses also expressed a very widely information requirements for tourism websites, which involves six basic tourism factors—eating, living, travelling, wandering, enjoying and shopping, as well as relevant tourism association information such as weather, news, products and prices. The questionnaire also lists the question “what are the most important factors for a tourism website success”, 52.5% of responses believed that the most important factor is “providing large amount, updated and attractive information”, followed by “fast access speed”, “good interactive function” and “refinement/exquisite page design”. The result means that tourism website users are very concern about the information content provided on tourism websites. Therefore information provision function is the first issue to be concerned in website design.

One of the common problems for tourism website development in China is the lack of integrative online information management. As there is no tourism website registration management system in China, it is very difficult for website designers to build links from one site to relevant sites and hard for them to obtain complete tourism information of the whole country or province. The CNNIC result [4] shows that about 14% of Internet users obtained tourism information from Internet, it was rated at the 9<sup>th</sup> of the 13 main kinds of information obtained from Internet. In our survey results, about 24% of users complain that tourism information provided in tourism websites cannot meet their requirements. For the question “what are the unsatisfied aspects for current tourism websites”, “not enough useful information” is listed as the second important item. The item’s rate is higher than “high connection fees” and “poor personal security”. Therefore, when information obtaining is still a main purpose for web users, increasing useful web information and improving web information management level are two major tasks of current tourism website development.

## 4.4 Information Interchanging and Interaction Functions

In the survey, “refined page design” is marked as the second important factor for a tourism website success by users. The result indicates that web page design is affecting users for receiving online service. Many tourism websites in China don’t have a clear target user group and promotion direction. Website designers don’t understand user requirement well. These websites only focuses on a pretty interface and put many page-items (some are relevant and some not relevant to the theme of the website), therefore, they may lose the characteristics of a tourism website and make users feel the site is not very trustworthy, dependable and reliable.

“Information interchange/interaction functions” is identified as the third important factor for a tourism website success in the survey results. A lot of users are interested in online chat, online consultation and email requiring. The results reflect that users require the online service that combing information content (such as tourism guide) and community (such as web consultation). Normally, many users like to get others’ opinions for landscape points before they have a tour. They thus wish to share ideas, information, experiences and knowledge with other tourists via the websites. Tourism websites are expected to provide an interactive space to users and service providers.

## 4.5 Doing Tourism E-Commerce via Websites

In this survey, only 2.5% of responses chose “web-based e-commerce” as a “purpose to visit tourism websites”. There were more than 1/3 of responses indicating that “the main disadvantage of tourism e-

commerce” is “security problems”, followed by “payment methods”, “online cost” and “information service quality”. Almost responses didn’t have any experience in online payment. Only 5% of responses had online ordering/booking experience. Therefore, for both questions “do you have any tourism e-commerce experience” and “are you satisfied with current tourism e-commerce”, most responses marked ‘NA’. Actually almost responses did not think they really need doing web-based tourism e-commerce urgently. There are several reasons for Internet users to keep tourism e-commerce away. The first reason is that most responses have middle or lower financial ability and they think that to participate e-commerce actions will have a higher cost than traditional way. Another reason is there are security and network technical problems in e-commerce transaction/payment systems to be solved. Users don't trust e-commerce applications well. Credit cards are not popular used in China is the third reason.

## 5. Components of Tourism Websites

A successful website is one that attracts users, makes user satisfactory [7]. Basically, user satisfaction is based on two groups of evaluation criteria: 'information content' and 'ease of use' [13]. 'Information content' is the assessment of information provided on the website. That is, it is useful and up-to-date, it matches user needs and links relevant sites to the users. 'Ease of use' includes E-commerce application format design, facilitated browsing, a search engine provision, accessing speed and user control of a transaction process. Based on the two criteria, the survey identifies a number of tourism website components. These components should be taken into account when designing a tourism website.

The first component is about information content published on websites. Tourism websites should publish useful, update and clear information about tourism products and services by using photos, audio and text [12]. The information involves destinations' attractions, activities, hotels, restaurants, transportation, tours, shops, entertainment, sports and recreations.

The second component is associate information provision. Associated information includes local maps, news, healthcare, laws and culture environment that are very helpful for user to make a tourism plan.

The next is online user supports that include a fast search engine, frequently asked questions, and allowing information and products to be downloaded by users. Interaction between users and systems is also a kind of important support to users. Interactive function helps users to share knowledge and experiences directly.

In order to facility tourists to arrange their tourism plans via Internet, the tourism websites should have enough links to relevant websites which provide online

information service for eating, living, travelling, wandering, joying and shopping. It should be encouraged for web designers to build more links with relevant websites, and more packages that integrate a group of relevant services together.

Online ordering/booking for tourism products and services is another important component. Ticket and accommodation booking is the most popular application in the aspect.

The last component is about building customer relationships with tourism companies by mining customer information via their direct interaction with the website. The customer information obtained can be used to create an online customer profile and build a specialized information provision according to the profile of the users.

The six components express the standard quality criteria for tourism website design. Another survey reported in [9] shows that about 80% of tourism websites in China only implement the first four components.

Online tourism service is still a new experience for most tourism managers, end-users and customers in China. As the technology is new, tourism managers cannot clearly define their expectations, and tourism companies have not got enough feedback from customers and their experiences. Therefore, website developers have to lead the process of defining the requirements of tourism web users. The provided components are expected to help them in the development of tourism websites.

## 6. An Evolution Model for Tourism Websites in China

Business website development typically begins simply and evolves over time with the addition of features as the site takes on more functionality and complexity. Based on literature review, this study proposes a five-stage evolution model for tourism websites development in China (Figure 2).

**Stage 1: Simple and isolated:** only presenting simple tourism information and contact details of tourism suppliers/agents. The basic information provided is regional tourism destination introduction with nice pictures. The websites' owners are mainly regional destination organizations. Very few links are built with other sites. Such kind of websites only implements component 1.

**Stages 2: Interactive and integrated:** various information relevant to tourism is presented, such as train/coach timetable, hotels and souvenir information. Supporting information (such as map and news) and product catalogue are provided. Users are allowed to

make enquiries about tourism products and services. Those websites have implemented component 1, 2, and 4.

**Stage 3: Linked and dynamic:** through a destination website, users can access relevant external products and services, including transport, accommodation, tourism foods/tools, culture activities, and training/conference centres. Product and service catalogues are provided with price information which can be changed by an online database. Such websites have implemented component 1 to 4.

**Stage 4: Online ordering/booking:** based on above stages websites are designed to allow customers to make a booking via email but the payment is still carried out by using a conventional method. Further, on-line payment will be provided with the use of credit cards.

**Stage 5: High-level, full-function, and comprehensive :** building registration with user ID, and using registration scheme to provide more personality and regular services to customers for direct purchase. The stage implements all six components.

Component \ Stage	1	2	3	4	5	6
Stage 1	Y	N	N	N	N	N
Stage 2	Y	Y	N	Y	N	N
Stage 3	Y	Y	Y	Y	N	N
Stage 4	Y	Y	Y	Y	Y	N
Stage 5	Y	Y	Y	Y	Y	Y

Fig. 2 Components and stages of tourism website development

## 7. Conclusions

China has obtained initial experience in the development of tourism websites and online tourism service. As a developing country, China has different E-commerce development environment, barriers and challenges from developed countries. Through the research, we found that the main barriers for tourism e-commerce development in China are Internet access speed, web information presence, site links and application security. Many tourism websites need to have a systematic design in information content and online service items. Tourism service characteristics should be presented in webpages. Information interaction functions (online ordering/booking) need to be implemented in a high level to meet the user requirement. The interface of tourism websites is expected to improve in ease of use. It is still a long process for tourism websites to realize online payment in China. The current tasks for tourism e-commerce development should focus on redefining online

information content, building helpful web links, providing customer oriented online services and implementing more effective online booking functions. Tourism online suppliers need to identify their target user groups and seek the way to meet users' requirements in developing tourism websites and improving tourism online service quality.

## References

- [1] Australia Daily (2002), 25 June 2002, <http://www.ausdaily.net.au/>.
- [2] Bullock, J. C. & Goble, C. A. (1997), Tourist-Conceptual Hypermedia Tourist Information, *The Eight ACM Conference on Hypertext and Hypermedia* 1997, United Kingdom.
- [3] Cano, P. V. & Prentice R. (1998), Opportunities for endearment to place through electronic visiting-www homepages and the tourism promotion of Scotland, *Tourism Management*, Vol. 19, No. 1.
- [4] CNNIC (China National Network Information Centre) (2001), <http://www.cnnic.net>.
- [5] Elliot S. R. (2000), Towards a Framework for Evaluation of Commercial Web Sites, *Electronic commerce: the end of the Beginning*, 13<sup>th</sup> International Bled Electronic Commerce Conference, June 2000.
- [6] Filippo. M. S. (2000), The Online Difference, *Travel Agent*, 2000, 3.
- [7] Liu C. & Arnett K. P. (2000), Exploring The Factors Associated With Web Site Success In The Context of Electronic Commerce, *Information & Management*, 2000, 38.
- [8] Lorraine, S. (1999), 2000 Outlook on The Online Travel Leisure Market, *Outlook Of Travel*, 1999.
- [9] Lu Z. & Lu J. (2002), Development, Distribution and Classification of Online Tourism Service in China, Third We-B International Conference, 18-29 Nov. 2002, Perth, Australia.
- [10] NUA Internet Surveys (1998), Data monitor: Travel Will be Largest Online Product By 2002, <http://www.nua.net/surveys/1998>.
- [11] Oliver, R. L. & DeSarbo, W. S. (1988), Response Determinants in Satisfaction Judgements, *Journal of Consumer Research*, 1988, 14.
- [12] Schiller, K. (2000), Touring Webbased Booking, *Travel Agent*, 2000, 10.
- [13] Smith A. G. (2001), Applying Evaluation Criteria to New Zealand Government Websites, *International Journal of Information Management*, 2001, 21.
- [14] Thompson, H. (2000), Capturing the Electronic Commerce Advantage: The Western Victorian Approach, 13<sup>th</sup> International Bled Electronic Commerce Conference, Bled, Slovenia, 2000.

# The Yield Management of Tourist Enterprises

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## Abstract

A silent revolution is taking place in the global service industry, including a lot of enterprises in tourist industry, affecting the way companies are managed and operated in a progressively deregulated economic environment. This is the yield management, which originated from the airline industry and is used by many different kinds of tourist enterprises.

This paper is dedicated to study the yield management in tourist industry, especially taking the Chinese tourist enterprises as the example. The fact that yield management is not understood well by so many tourist companies is the reason why this paper is written. The character of being intangible, vulnerable and its particular cost structure are the most important reason for tourist enterprise to apply yield management. When studying the current situation of tourist enterprises in China, some problems facing these enterprises have been found, including that many tourist enterprises do not practice marketing segmentation properly, the particular cost structure do not influence the revenue management, and so on. Finally, the paper describes in detail how to solve problems mentioned through using yield management. Three elements are interdependent, that is, understanding the problems involved, the important principle of yield management application and the process of practicing yield management.

## 1. The Background of This Paper

Whenever we compare the operation of airlines in China and other countries, we pay attention to the fact that the foreign airlines offer price which varies with booking time, customer segmentation and consumption style, etc. But Chinese airlines followed the fixed price for all the flights in the past, where there was no yield management. And now in the market it seems that Chinese airlines offer various price. That is not yield management. In fact, yield management is not understood well by so many tourist companies. Hence it is necessary to communicate the concept of yield management.

After more than 20 years' development, the tourist industry in China has entered another important stage. Because of the low entry barriers and high investment return, the tourist industry has grown very rapidly. However, the severe competition brings about negative effects, one of which is the rate of profit of

the whole industry fall, for example, in 1998, the international tourist operators' average rate of profit is only 1.8%<sup>[1]</sup> On one hand, it is because that the profit is becoming average, on the other, most tourist enterprise do not follow scientific method to analyze the customer segmentation, and fail to connect the pricing strategy with its profit realization. The simple competing method only includes cutting the price, which is far from competitive in the complicated and changing market.

## 2. The Reason Why Yield Management is Important to Tourist Enterprises.

Yield management refers to selling the products to the right customers at the right price at the right time is the central idea of yield management. The enterprises can get the most profit by targeting segmented micro markets to maximize its revenue. The tourist enterprises share some common product characteristics that are, the intangibility, vulnerability and particular cost structure. Yield management can bring benefit to the enterprises having such characters.

### 2.1 The perishable product

Many of the tourist enterprise's products belong to perishable product. Unlike the tangible products, the service in tourist enterprises cannot be stored and sell in another time. In the enterprises with perishable product, time element is very critical in selling the products. Typical examples include airline seats and hotel rooms. Once a flight left the ground, the seats cannot be sold any more; once a night has passed, the bed cannot be slept in.

### 2.2 Cost Structure

The second character is high fixed cost, low variable cost of tourist enterprises. Entertainment parks, hotels and airlines can be very good instances to illustrate this point. The variable costs of the product are low so an incremental sale does not cost the vendor much, but enables the product to be sold at a wide range of prices rather than letting it unsold and spoil. In other words, selling such kind of products for any price, which is over the variable cost, is better

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[1] WEI Xiaolan, "Difficult Situation and Solution of Chinese Travel Service," *Tourism Review*, 1999, 4

than not selling at all.

### **2.3 Limited Capacity of the product**

The third character is limited capacity of the product. For example, the number of beds in hotels, cars in the car rental firms, seats in the plane is limited. In this kind of situation, it is very expensive or impossible to increase the available units of the product.

### **2.4 Product being able to be booked in advance**

The fourth is that the product or service can be sold in advance. This ability helps to facilitate segmenting the market, which is an important characteristic of yield management. In airline industry, the traditional usage of yield management can be seen in the separation of business tickets and economical tickets in the airline. That is the basic segmentation in airline industry. But that is far from enough. Now the situation is that more precise segmentation is needed to achieve better performance and revenue.

## **3. Current Situation of Tourist enterprises and problems**

When we study the tourist enterprises and analyze the current situation of tourist enterprises in China, we find some problems facing these enterprises, which can be solved by adopting yield management.

### **3.1 Current Situation of Tourist enterprises**

Since China adopted the Opening and Reform policy, with the development of the tourist industry, tourist enterprises such as airlines, hotels and travel companies have grown very rapidly. And these companies are facing very rosy prospect. Up to now, in China, there are about 17000 tourist enterprises, with 300 billion fixed property value, 200 billion fixed property investment, the direct employee in the industry amounts to 1800 thousand, and annual operational revenue achieves 15 billion Yuan.<sup>[2]</sup>

### **3.2 Problems facing Chinese tourist enterprises**

Although the tourist enterprises in China develop very fast, there are serious problems facing the whole industry. On the one hand, the tourist industry grows every year, on the other, the performance of tourist enterprise in terms of revenue is becoming poor. The problems remained for years, including that many tourist enterprises do not practice marketing segmentation properly, the particular cost structure do not influence the revenue management, the current pricing system does not reflect particular

characteristic of tourist enterprises, and so on.

### **3.2.1 Structure Adjustment is disregarded**

In the past 20 years, the development of tourist industry has been depended on large-scale investment and construction. The profit of tourist enterprises has been realized by raising the product price. When the market stayed in the seller's market, it is possible to maintain operation. But when the tourist enterprises are facing the changing exterior environment, especially the serious competition of enterprises from home and abroad, at the same time, the seller's market has turned to buyer's market, the structure conflicts of the industry has become obvious. Taking hotel as an example, for years hotels adopt one fix rate, the change of the market does not influence the operation strategy of hotels. Many hotels do not pay attention to prepare guest history file, and not realize its importance and hotels disregard the market segmentation. About travel agency, the administration does not pay enough attention to the low profit situation and long-term development, thus many poor performance aiming to short-term profit can be found in many travel companies.

### **3.2.2 Lack of competitiveness**

Nowadays, many tourist enterprises have high operational cost. In terms of competitiveness, Chinese enterprises are poor compared with many foreign companies.

For example, a lot of single hotels have been built. They are small in terms of scale, do not join in any global reservation network, and also cannot afford to invest any management software. The situation of travel agency is more difficult, small companies cover a large percentage of the whole industry. These small companies compete by blindly cutting price, and accordingly lower the quality of the products. Hence, a lot of complaints take place. Checking airlines and car rental companies presents the same finding.

### **3.2.3 Too much interference of the government**

For long, tourist industry has been interfered by government of many levels, which hindered the natural competition of enterprises in the market. What is most evident is the transportation industry. From the deregulation of American airlines, we can draw a conclusion that the free pricing stage owing to deregulation is the preparation phase for enterprises to adopt yield management willingly. Taking airline as an example, for years, the airline industry has been in charged by China Civil Aviation Bureau. The decision of airplane purchase, personnel administration is made by the bureau, the airline companies cannot make these decisions that should be their responsibility. So the companies cannot join in the market competition as true enterprise. The bureau also controls the pricing and route decisions. Many companies are poor in

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<sup>[2]</sup>Statistic Report of China National Administration of Tourism

terms of management; fail to adopt tools to combat in the market, such as pricing, product strategy, and so on. At the same time, the service of airline companies does not differentiate from each other, so the competition between them becomes the simple cutthroat competition.

### **3.2.4 Low Level of Technology in Tourist Products**

In developed countries, technology can be seen more often than before in tourist enterprise. But in China, the technology level in tourist enterprises is low. Taking travel agencies as example, many companies do not join in any central reservation system. Even the use of computer is limited. So the operational cost is quite high, lowering the profit level. Now China has become a member of WTO, tourist enterprises will face more fierce competition from foreign countries. The low level of technology adopted will not result in fast, accurate and timely service, which is the most important characteristic of future tourist industry.

Besides the above problems mentioned before, we can also find other problems, such as poor infrastructure condition, sustainable development of tourist industry is facing difficulties, and not sufficient domestic tourist consumption. There are many reasons, but it is important to pay more attention to the interior management mechanism, in order to achieve efficient competition.

## **4. How to Solve the Problems**

Yield management, also cannot solve all the problems facing tourist enterprises, can help greatly to solve problems mentioned. Yield management system helps companies to make good decision through data analysis and forecast, and achieve better service performance. It should be realized that the most important reason is that there are many attitude mistakes and operational barriers, so the starting point to practice yield management is to understand the problems involved.

### **4.1 Attitude Mistakes and Operational Barriers**

In reality, the idea of yield management is being used by some of the firms, but not deeply. What is hindering the using of yield management? We have met some common misunderstandings upon this concept. The following is a look at three popular misunderstanding about yield management's role and effect.

#### **4.1.1 Misunderstanding 1**

The first and most popular misunderstanding about yield management is that it is a computer system. Discussions of yield management appear to be inevitably linked to computer systems. With computer-based tools as its key component, yield

management can be defined as a decision support system. As being introduced before, yield management can be used to forecast demand, to optimize reservation-inventory allocations, to limit discount availability, and so on.

But yield management is neither a purely computer system nor a set of mathematical techniques. In fact, other yield management practices can be implemented with little or no investment in computer resources. Yield management programs also involve other elements other than computer modeling, for example, education and training, an appropriately designed and delivered product, and corporate policies and procedures that encourage revenue enhancement. Those three areas must be addressed in a coordinated manner when developing or enhancing a yield management program.

#### **4.1.2 Misunderstanding 2**

Another misunderstanding is that yield management takes control away from employees.

Yield management tools may accomplish some routine actions previously performed by employees. It's easy to understand. However, a yield management program, containing tools that recommend specific courses of action, will not take over a company's decision making.

For example, yield management tools might suggest that no more reservations be accepted at a specific discount rate for a particular night, or that a group rate of \$75 is too low for a certain set of nights. But the ultimate decision and responsibility for accepting those recommendations, or over-riding them and choosing a different course of actions, rest with a hotel's staff.

#### **4.1.3 Misunderstanding 3**

The third misunderstanding is that yield management works only when demand exceeds supply

The best-known applications of yield management are overbooking and discount control. They are very useful when excess demand exists. That causes many people believe that yield management only works when demand exceeds supply. But in fact, not only when demand exceeds supply, but also when supply exceeds demand, yield management can be reliable.

For example, Marriott's use of low-price advance-purchase rates is an attempt to attract customers who would normally stay at low-priced hotels. Those new products do not create demand so much as under the previous pricing regime. Yield management helps a hotel modify its pricing structure and control the sale of its product so that the hotel can expand the appeal of its product while mitigating revenue dilution that would result if such changes were not controlled.

So, besides price discounting, yield management can identify opportunities to improve the pricing

structure. Raising and lowering prices dynamically for a given date, depending on demand, is a business decision. Yield management focuses on how much of a product to sell at established prices; it works all the time.

## **4.2 Principle of Yield Management Application**

In order to apply yield management, enterprises should follow certain principles. The successful yield management companies also create some organizational characteristics.

Continuous improvement should be embraced and the company is committed to the strategic process of yield management; it should create or use proper computerized yield management software to better their performance.

The company should thrive on changes, at the same time it emphasizes its perishable inventory, tries to connect the changes inside and outside the company with the sales of the products. And when the company balance its inventory and demand, what is emphasized is not only cost, the competing environment is more important.

The company should do a lot of customer research, and recognize the customer's expectation about the products and the price, which set the base of their comprehensive pricing strategy. What's more, the company must forecast the potential demand at different price or sales point, and allocate its capacity according to the structure balance.

It is important that such company rarely oversells prime inventory while rarely undersells fringe inventory; they limit the amount of discount business; and they always attach various conditions of sale to every price offer, and so on.

In sales, the company pays more attention to the micro market, that is the different customer types, not the whole market. Thus fixed price should not be followed.

The company should make good use of the value cycle of every kind of product, and try to sell it when it is highly valuable. This decision should be based on fact, instead of imagination.

## **4.3 The process of practicing yield management and solving the problems**

In yield management, the total revenue is more important than sales volume or sales price. In order to achieve that, five parts of process are necessary. They are market segmentation, price management, demand forecast, capacity management and booking negotiation.

### **4.3.1 Market Segmentation**

No company can satisfy the needs of all customers. In order to achieve success, it is necessary to do market segmentation. Not only tangible goods can

have differentiated markets, but also service can identify evident segments. Market segmentation is important in that various customer group can be recognized according to their behavior, thus different price structure, business strategy and other marketing motivation can be established. According to Philip Kotler, in segmenting the market, the criteria such as geographic, demographic, psychological and social elements can be used.<sup>[3]</sup> In fact, besides these criteria, service can also be segmented according to the willingness to pay for a product or service, and time when customers need the product as well. In tourist industry, according to these criteria, tourists can be listed into different categories. Different types of customers have evidently various price acceptance levels.

### **4.3.2 Price Management**

Price management refers to that the enterprise provide different price to various segments according to the change of demand systematically.

Taking airline as an example, if the airline has mastered the data about the customer type and their different demand, it can set up different price level and price structure. For example, the airline can provide a discount price to those customers who book early. In fact, both the discount price in low season and the high price in high season of many tourist enterprises belong to price management.

### **4.3.3 Demand Forecast**

A company forecast the future demand according to the analysis on past sales and known trend in the future, and based on this, the company can rationally and accurately forecast the scale of different segments and according price acceptable.

Forecast is a very important process on yield management. In order to forecast systematically, the company must possess data information and scientific statistical method. The company must have both interior and exterior information.

### **4.3.4 Capacity Management**

To manage capacity of a company means to limit or adjust the availability of certain product or service according to the demand of customers. In fact, some enterprises can change the capacity, but some cannot. But some enterprises can class the capacity and implement certain limitation to some product.

### **4.3.5 Booking Negotiation**

Because most products and services of many tourist enterprise can be booked, when customers book, the company can negotiate effectively. When there is a

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<sup>[3]</sup> Philip Kotler, *Marketing Management*, tenth edition, Prentice-Hall, 2001,10

chance that the company can negotiate with the customer, it should try to sell the most expensive product and realize the greatest value of the products.

To sum up, yield management is a scientific method to make the enterprise realize optimal revenue, whose core is price control, capacity management and booking sales. Moreover, we believe it is the right time for our enterprises to understand this idea and implement this business practice.

## References

- [1] Goeldner with Ritcher, *Tourism Practice, Principles, Philosophies*, John Wiley & Sons, Inc., 1995
- [2] LI Guijin, Airline Market Competition Calls for “Rationality”,  
[www.airshowchina.com/review/minhang/yunshu/lixing.htm](http://www.airshowchina.com/review/minhang/yunshu/lixing.htm)
- [3] Philip Kotler, *Marketing Management*, tenth edition, Prentice-Hall, 2001
- [4] Philip Kotler, John Bowen, James Markens, *Marketing for Hospitality and Tourism*, 2nd edition, Prentice Hall International, Inc. 1999,
- [5] S.Medlik, *Dictionary of Travel, Tourism and Hospitality*
- [6] Stephen J Page, *Transport and Tourism*, Longman limited 1999
- [7] WEI Xiaoan, “Difficult Situation and Solution of Chinese Travel Companies”, *Tourism Review*, 1999, 4
- [8] *Yield Management in Small and medium-sized enterprises is the tourism Industry*, General Report, 1995

# Inventory Management with the Internet-Based Direct Channel in a Two-Echelon Supply Chain System

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## Abstract

We present a two-echelon dual-channel inventory model in which stocks are kept in both the manufacturer warehouse (upper echelon) and the retail store (lower echelon), and the product is available in two supply channels: the traditional retail store and the web-based direct channel. The system receives stochastic demand from two customer segments: those who prefer the traditional retail store and those who prefer the web-based direct channel. Any order placed through the direct channel is fulfilled through direct delivery from the manufacturer warehouse. When a stockout occurs in either channel, customers are willing to shift the channel with a known probability. Customers who are unwilling to shift the channel result in lost sales. In order to develop operational measures of supply chain flexibility, we define a cost structure which captures two different operational cost factors: inventory holding costs and lost sales costs. Several insights are evident from the numerical experiments. We also examine the performance of two other possible channel strategies: retail-only and direct-only strategies. Simulation outcomes indicate that the dual-channel strategy outperforms the other two channel strategies in most cases, and the cost reductions realized by the flexibility of the dual-channel system could be very significant.

## 1. Introduction

The advent of the Internet has prompted many manufacturers to redesign their traditional channel structures by engaging in direct sales. Consider a two-echelon inventory system that consists of a manufacturer with a single warehouse at the top echelon and a retail store at the bottom echelon. Suppose orders placed online are filled through direct delivery from the top echelon. Opening a web-based direct channel alongside the existing retail store may cause havoc on the product demand structures, and thus requires the company to redesign the optimal inventory allocations. In this paper, we construct an analytical model and define a cost structure which captures the inventory-related operational costs to evaluate the performance of a two-echelon dual-channel supply system.

The pervasive presence of multi-echelon inventory systems throughout the business world has been recognized in a long time. The concept of echelon stock

was first introduced by Clark and Scarf (1960). Inventory control in multi-echelon systems is known as a challenging research area. Because of the complexity and intractability of the multi-echelon problem, Hadley and Whitin (1963) recommend the adoption of single location, single echelon models for the inventory systems. Sherbrooke (1968) constructs the METRIC model, which is capable of identifying the optimal stock levels that minimize the expected backorders at the locals subject to a budget constraint. This model has been considered as the first multi-echelon inventory model for service parts. Thereafter, a large set of models that generally seek to identify optimal lot sizes and safety stocks in a multi-echelon framework were produced by many researchers (e.g., Deuermeyer and Schwarz 1981, Moinzadeh and Lee 1986, Svoronos and Zipkin 1988, Axsäter 1993, Nahmias and Smith 1994, Aggarwal and Moinzadeh 1994). In addition to analytical models, simulation models have also been developed to capture the complex interactions of the multi-echelon inventory systems problem (e.g., Clark and Trempe 1983, Pyke 1990, Dada 1992, Alfredsson and Verrijdt 1999).

The study of multi-channel supply chains in the direct versus retail environment emerged only recently. The focus of this stream of literature is on the channel competition and coordination issues in the setting where the upstream echelon is at once a supplier to and a competitor of the downstream echelon (e.g., Rhee and Park 1999, Tsay and Agrawal 2001, Chiang, Chhajed and Hess 2002). These papers present the dual-channel design problem by modeling the price and/or service interactions between upstream and downstream echelons.

The theoretical basis for multi-echelon dual-channel inventory problem has not yet been well developed. Toward this propose, we incorporate the direct channel into a traditional two-echelon inventory system to determine the optimal inventory levels for each echelon.

## 2. The Two-Echelon Dual-Channel Inventory Model

Consider a two-echelon dual-channel supply system that consists of a manufacturer with a single warehouse at the top echelon and a retail store at the bottom echelon. Figure 1 illustrates the topology and product flows of the system. The complete set of assumptions made for the inventory model is listed below.

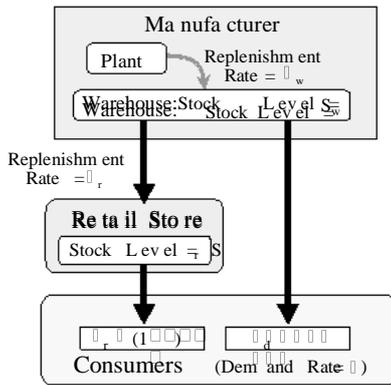


Figure 1: Two-Echelon inventory system with direct channel

## 2.1 Model Assumptions

- (1) The product is available for customers in both the retail store and the direct channel. Any order placed through the direct channel is fulfilled through direct delivery from the manufacturer warehouse. Demands across the two different channels are independent, and the total demand rate for the product in the system is  $\lambda$ . Specifically, customers are assumed to arrive at the retail store according to a Poisson process with constant intensity  $\lambda_r(1-\alpha)$ , and orders placed through the direct channel are in accordance with a Poisson process with rate  $\lambda\alpha$ , where  $\alpha$ , the direct channel preference rate, is defined as the proportion of potential consumers who would prefer buying directly from the manufacturer.
- (2) When the retail store is out of stock, customers are willing to shift from the retail store to the direct channel with a known probability called the retail channel diversion rate,  $\beta$ . Similarly, when the manufacturer warehouse is out of stock, customers are willing to shift from the direct channel to the retail store with a known probability called the direct channel diversion rate,  $\beta$ . When a stockout occurs in either channel, customers who are unwilling to shift the channel result in lost sales. Customers are assumed to be lost when both the retail store and the manufacturer warehouse are out of stock.
- (3) The warehouse replenishment lead-time and the retail store replenishment lead-time are assumed to be exponentially distributed with mean  $w$  and  $1/\mu$  respectively. A one-for-one replenishment inventory policy is applied, and replenishment backorders from the retail store are allowed at the manufacturer warehouse. A customer served from stock on hand will trigger a replenishment order immediately by EDI (electronic data interchange). Therefore, the information lead time is assumed to be zero. Under this replenishment inventory policy, the inventory position is kept constant at a base-stock level. The base-stock levels at the warehouse and the retail store are denoted by  $S_w$  and  $S_r$ , respectively.

## 2.1 The Markov Model

Based on the assumptions in the previous section, the corresponding Markov model can be constructed with the state space  $(x, y)$ , where

$x$  = stock on hand at the manufacturer warehouse,  $0 \leq x \leq S_w$ , and  
 $y$  = stock on hand at the retail store,  $0 \leq y \leq S_r$ .

Note that the stock hand at the manufacturer warehouse can be negative due to the replenishment orders from the retail store. There are four events that lead to a change of state: 1) a customer arrives at the retail store, 2) an order is placed through the direct channel, 3) a replenishment order arrives at the manufacturer warehouse, and 4) a replenishment order arrives at the retail store. Let  $p_{xy}$  be the steady-state probability that  $x$  items are on hand at the manufacturer warehouse and  $y$  items are on hand at the retail store. Then we can find the steady-state probabilities by solving the linear equation system that contains the balance equations and the normalizing constraint.

## 3. Cost Structure

In this section, we conduct an economic analysis of the model to evaluate the performance of the two-echelon dual channel system. We define a cost structure that takes into account two different operational cost factors, inventory holding cost and lost sales cost. In the sections that follow, these cost factors are specified in terms of the steady-state probabilities.

### 3.1 Inventory Holding Cost

Let  $h_w$  and  $h_r$  be the inventory holding costs in dollars incurred by the firm per item per time unit at the manufacturer warehouse and the retail store, respectively. Then, given the steady-state probabilities, the total inventory holding cost,  $C_H$ , is determined by

$$C_H = h_w \sum_{x=1}^{S_w} \sum_{y=0}^{S_r} x p_{xy} + h_r \sum_{x=0}^{S_w} \sum_{y=1}^{S_r} y p_{xy}.$$

Clearly, the first portion of  $C_H$  captures the holding cost from the manufacturer warehouse, while the second part reveals the holding cost from the retail store.

### 3.2 Lost Sales Cost

Recall that when a stockout occurs in either channel, customers who are unwilling to shift the channel result in lost sales. Moreover, customers are lost when both the retail store and the manufacturer warehouse are out of stock simultaneously. Assume that the cost of losing a customer is 1 per customer. Then the total lost sales cost incurred by the firm, denoted by  $C_L$ , can be determined by the steady-state probabilities, and is given by

$$C_L = 1 \cdot 1 \cdot r \cdot r \cdot \frac{S_w}{x \cdot 1} \cdot x_0 \cdot 1 \cdot 1 \cdot d \cdot d \cdot 0 \cdot x \cdot \frac{S_r}{y \cdot 1} \cdot X \cdot xy$$

$$\cdot 1 \cdot r \cdot d \cdot x \cdot \frac{0}{x \cdot \frac{S}{x}} \cdot x_0$$

Note that the first portion of  $C_L$  reflects the lost sales cost from the retail store caused by those customers who are unwilling to shift the channel when the retail store is out of stock, the second portion describes the lost sales cost from the direct channel caused by those customers who are unwilling to shift the channel when the manufacturer warehouse is out of stock, and the last portion captures the lost sales cost due to the stockout in both channels.

### 3.2 Total Cost and Optimal Base-stock Levels

In the model, the only decision variables are the base-stock levels,  $w$  and  $S$ . The total cost which is function of  $w$  and  $S$  is defined as the sum of the inventory cost and the lost sales cost,  $C_L$ . The objective is to find the base-stock levels that minimize the total cost.

### 4. Comparison of Channel Performance

Instead of using both the retail store and the direct channel, a firm can just use either one of the two channels to fulfill the demand. After evaluating the performance of the dual-channel strategy, we also investigate the performance of the other two channel strategies, retail-only strategy and direct-only strategy. In order to compare the channel performances, the numerical results from the two demand fulfillment strategies are juxtaposed with the results from the dual-channel strategy discussed before. The results show that the total cost of using the retail-only strategy increases in the direct channel preference,  $\alpha$ , while on the other hand, the total cost of using the direct-only strategy decreases in  $\alpha$ . We find that in most cases the dual-channel strategy outperforms the other two channel strategies for all values of  $\alpha$ .

Figure 2 illustrates the cost of using dual channels relative to using one single channel (the ratio of the total cost from using dual channels to the total cost from using either the retail store or the direct channel, depending on whichever results in a lower cost). We see that when the value of  $\alpha$  is around 0.5, that is, when the number of direct customers is close to the number of retail customers, the dual-channel strategy could lead to an impressive cost reduction. If we calculate the cost reductions that are obtained by using dual-channel strategy (compared to using one single channel), we learn that when  $\beta = \beta = 0.75$ , the average cost reduction for all values of  $\alpha$  is 54%, and when  $\beta = \beta = 0.25$ , the average cost reduction for all values of  $\alpha$  is 73%. It is clear that when the values diversion rates are low, the cost reductions realized by the dual-channel strategy are remarkable. The result reflects the fact that, when customers are less willing to deviate from their desired channel, using dual channels helps to reduce the number of losing customers, and thus leads to a lower total cost.

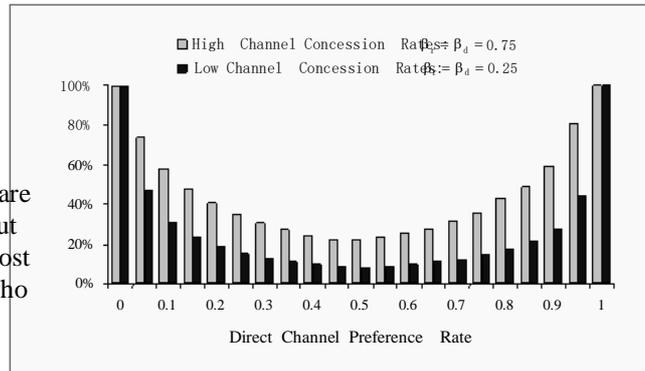


Figure 2: Cost of using dual channels relative to using one single channel

### 5. Concluding Remarks

The two-echelon dual-channel inventory model presented in this paper is constructed based on queuing theories. We analytically develop operational measures of supply chain flexibility. We define a cost structure which captures two different operational cost factors: inventory holding cost and lost sales cost. Our analysis of the model leads to an exact evaluation of system performances.

Several variations of our performance evaluation procedure are possible. For example, we have used the inventory-related cost as a criterion to evaluate the channel performance. However, sometimes achieving a high customer service level is an important objective for the system. In this case, we can easily include fill rates in the constraints or in the objective of the system optimization model for the performance evaluation.

We are not aware of any inventory model that handles the multi-echelon system with multiple channels receiving demand from different market segments. Our model has provided some insights in this important line of inquiry. However, due to the complex nature of the problem, the model is subject to some assumptions and therefore, has some limitations. For example, the results from our model may not hold if different inventory policies are applied. A more extensive investigation in this area is warranted.

### References

- [1] Aggarwal, P. K., K. Moynzadeh. 1994. Order expedition in multi-echelon production/distribution systems. *IIE Trans.* 26 86-96.
- [2] Alfredsson, P., J. Verrijdt. 1999. Modeling Emergency Supply Flexibility in a Two-Echelon Inventory System. *Management Sci.* 45 1416-1431.
- [3] Axsäter, S. 1993. Exact and approximate evaluation of batch ordering policies for two-level inventory systems. *Oper. Res.* 41 777-785.
- [4] Chiang, W. K., D. Chhajed, J. Hess. 2002. Direct Marketing, Indirect Revenues: A Strategic Analysis of Dual-Channel Supply Chain Design. forthcoming in *Management Science* (2002).

# The Realization of a Stochastic Optimization Model for the Empty Container Inventory Based on EDI Information

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## Abstract

This paper explores the feasibility of realizing the optimization of the empty container inventory based on EDI information. Firstly the basic structure of the stochastic optimization model for the empty container inventory has been described and two models including the infinite and finite horizon model were constructed. Then several statistical test have been taken and the distribution of the inland turnover time of the empty container, the empty containers' supply and demand identified. Finally we adopt PB to develop the DSS for the stochastic optimization of container inventory based on the shipping EDI information.

Key words: EDI, empty container, DSS

## 1. Identification of the problem

With the rapid development of the container transportation and the fierce competition on the market, how to reasonably determine the empty container inventory so as to reduce the running cost has become one important issue that all the container transportation enterprises are facing to.

Essentially the reasonable determination of the level of the empty container inventory falls into the scope of the optimization of the empty transport vehicle's inventory. In general, the present research is focusing on the following two aspects: to estimate the imbalance coefficient of empty container flow by experience or statistic samples, to realize the optimization of the empty containers inventory by means of the optimization models mainly the programming model. Because of the quite great uncertainty of the container flow, it is unavoidable to collect large amount of data to support the realizing of the quantified model to optimize the empty container inventory. So this paper is ready to take a systemic study on the information transmitted through the shipping EDI platform and the construction of the stochastic optimization model, then to explore the feasibility of realizing the optimization of the empty container inventory based on EDI information.

## 2. The analysis on the function and data structure of shipping EDI platform

Transmitting the information is the traditional core function of the information service provided by the traditional EDI platform, but the content of the information service has begun to change under the present network environment, and to emphasize particularly on providing the service of the value-added information step by step. What is the value-added information? Comparing with the original information, it has an obvious increase in the content of the information obtained by reasoning, analyzing and processing a group of correlative information. For the shipping EDI platform, the developing tendency in the future is how to further dig and process the information transmitted through the shipping EDI platform rather than to transmit the information simply, and provides more value-added information to the EDI users in their daily operation. Among which, it has been one of the attentions how to provide the information support for the reasonable determination on the empty container inventory.

Now the types of information transmitted through the shipping EDI information platform are IFCSUM, BAPLIE, COSTCO, EXPUSL, CODECO, COEDOR, COARIS, ACKIAG, COARIO, COARID, and so on. From these information, we can get many valued results. For example, IFCSUM contains much information regarding the quantities and directions of the empty container flow. We can identify the running rule of the empty container flow by analyzing IFCSUM. We will explore this issue later. Here we only summarize that it is possible to realize the stochastic optimization of the empty container inventory based on this EDI information.

## 3. The stochastic optimization model for the empty container inventory

### 3.1 General Description

The basic structure of the stochastic optimization model for empty container inventory based on the storage theory can be described as follows:

$$F = (T, Q, X, D, S, L) \quad (1)$$

In the formula above:

T stands for the length of the planning time, we classify it into the type of the finite and infinite;

Q stands for the fact whether the empty containers' shortage in a short time is allowed or not;

X stands for the fact whether the model considers the empty container inventory of one point or multiple-points;

D/S stands for the fact whether the demand/supply of the empty containers is stable or random;

L stands for the fact whether the allocation and transportation of the empty containers need to take time or not;

We can construct several models based on the above basic structure. Because of the limitations of pages, we are only giving the infinite and finite horizon models which consider only one point.

### 3.2 The infinite horizon model

#### 3.2.1 The basic model

Suppose the length of the planning time is infinite. The point for considering is lack of empty container. The shortage of supply of the empty container is not allowed. Let the demanding distribution of the empty containers follows the distribution of  $G(x)$ , and the replenishing time of the empty containers is zero. The strategy  $(s, S)$  is adopted.

According to the above conditions, we argue that with the infinite planning time horizon, the attention can be focused on the period of one cycle. Suppose the inventory level at the beginning of the period is  $I$ , the amount of the empty container during this period to replenish is  $Q$ , then the maximum level can be reached to  $R=I+Q$ . We also suppose the demanding amount of the empty container during this period is  $x$ . Hence,

If  $R \geq x$ , then the expected cost is equal to:

$$E(C_1(R)) = \int_0^R h(R-x)dG(x) + \delta \times k(R-I) \quad (2)$$

In the above formula,  $h$  is the storing cost of the empty container for the single period, and it is suppose that no storing cost has occurred for the empty container distributed in this period.  $k$  is the distributing cost.

If the distribution of empty containers happened,  $\delta=1$ ; otherwise  $\delta=0$

If  $R < x$  then the expected cost is equal to:

$$E(C_2(R)) = \int_{R+1}^{\infty} b(x-R)dG(x) + \delta \times k(R-I) \quad (2)$$

Here,  $b$  means the temporary leasing cost of the empty container.

So, the total expected cost is:

$$E(C(R)) = \int_0^R h(R-x)dG(x) + \int_{R+1}^{\infty} b(x-R)dG(x) + \delta \times k(R-I) \quad (4)$$

Let the derivative of the  $E(c(R))$  is zero, then we can get  $R^*$  (namely  $S^*$ ). The next step is to obtain the value of the replenishing point ( $s^*$ ) by taking marginal analysis in the following way:

If we replenish the empty container at the beginning of the period, then the expected cost is equal to:

$$E(c(I)) = \int_0^I h(I-x)dG(x) + \int_{I+1}^{\infty} b(x-I)dG(x) \quad (5)$$

If we don't replenish the empty container at the beginning of the period, then the expected cost is equal to:

$$E(c(R)) = \int_0^R h(R-x)dG(x) + \int_{R+1}^{\infty} b(x-R)dG(x) + k(R-I) \quad (6)$$

If  $E(c(I)) \geq E(c(R))$ , then it is not necessary to replenish the empty container. Namely:

$$\int_0^I h(I-x)dG(x) + \int_{I+1}^{\infty} b(x-I)dG(x) \geq \int_0^R h(R-x)dG(x) + \int_{R+1}^{\infty} b(x-R)dG(x) + k(R-I) \quad (7)$$

When  $I=R$ , the above inequality is obviously held, therefore, it is affirmative to have the solution.

When  $I < R$ , it is also possible to held the above inequality, then the minimum of the  $I$  is  $s$ .

#### 3.2.2 The modification to the basic model

In the above model, we suppose that there is no delay in the replenishing of the empty containers, which can greatly decrease the complexity of the model. In practice, it is obvious that there is the delay of empty containers replenishing. So we must consider this issue and modify the basic model in the following.

The consideration of the delay of empty containers replenishing has two affects on the model:

One affect is the amount of empty containers stored at the beginning of this period which not only includes the amount of empty containers at the end of the last period, but also includes the empty containers that should have been distributed in the previous periods but arrive in this period. i.e. The empty container inventory of this period equals to the ones at the beginning of the period plus the ones which are in the procedure of transport.

The other affect is that the time length of decision-making should extend from this period to the delaying period. i.e. The demand of empty container considered not only includes the one of this period but also includes the empty container demand which happens in the delaying time.

Bases on the above two effects, we can make the following modification to the basic model:

$$I' = I - \frac{\tau}{\tau_0} \int_0^{\infty} x dG(x) \quad (8)$$

$$E(C_j(R_j)) = \int_0^{R'} h(R - I - \frac{\tau}{\tau_0} x) dG(x) + \int_{R'+1}^{\infty} b((1 + \frac{\tau}{\tau_0})x - R) dG(x) + k(R - I) \quad (9)$$

In the above formula:

$T$  is the delaying time,  $T_0$  is the span of this period which has been considered.

$$R' = \frac{R}{1 + \frac{\tau}{\tau_0}} \quad (10)$$

### 3.3 The finite horizon model with one point

#### 3.3.1 Basic model

In the above, we discussed the infinite model and take one period to consider. However, it is not suitable in the finite horizon model. We will construct the model in the following way.

Suppose there is  $n$  periods. The correlative assumption is the same as the infinite model.

In the  $j$ th period, the whole expected cost is equal to:

$$E(C_j(R_j)) = \int_0^{R_j} h(R_j - x) dG(x) + \int_{R_j+1}^{\infty} b(x - R_j) dG(x) + \delta k(R_j - I_j) \quad (11)$$

$$\delta = \begin{cases} 1 & R_j > I_j \\ 0 & R_j \leq I_j \end{cases} \quad (12)$$

Then we can define the whole of the optimization object as:

$$\text{Min } C = \sum_{j=1}^n E(c_j(R_j)) \quad (13)$$

To the above model, we can adopt the dynamic programming theory to solve.

Assuming  $I$  is the status variable,  $R$  is the decision variable, the equation of status transferring is:

$$I_j = R_j - D_j \quad (14)$$

Suppose  $E(g_j(R_j))$  is index function,  $E|g_j(I_j)|$  is the optimization function, then the reversing model can be constructed as follows:

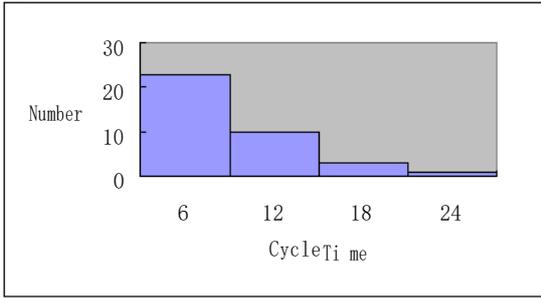
$$E|g_j(I_j)| = \min_{R_j} \{ E[C_j(R_j)] + E|g_j(I_j)| \}, \quad E(g_{n+1}(I_{n+1})) = 0 \quad (15)$$

From the above models, We can get  $R_j^*$  of every period. The  $R_j^*$  is the  $S_j^*$  of the strategy of  $(s_j^*, S_j^*)$ . The obtaining of  $s_j^*$  is the same as the infinite horizon model.

#### 3.3.2 The modification to the basic model

The above model is only suitable for this condition that delaying time of empty container replenishing is zero.

If the delay were considered, the following adjustment



should be given:

$$I_{j+1} = I_j + Q_{j+1} - D_j$$

$$E(C_j) = \int_0^{\infty} \int_0^{\infty} h(I_j + Q_{j+1} - x) dG(x) f_j(Q_{j+1}) dQ_{j+1} \quad (16)$$

#### 4. The information support for the optimization of the empty container inventory provided by the shipping EDI platform

According to the above stochastic model for empty container inventory, we can find the table:

In order to realize numeric simulation application, it is essential to acquire some statistic distribution of random phenomena and obtain the result of optimization by running the test. The random phenomena mostly include the distribution of empty containers' demand and supply and the turnover of empty containers and so on. The information can be acquired completely through the information transmitted by the shipping EDI information platform. In order to explain the feasibility further, we take advantage of IFCSUM, CODECO and COEDOR to determine the statistic distribution of all kinds of random phenomena.

#### 4.1 The distribution of the inland cycling empty containers time

According the information of EDI, We can get the statistical data of the inland cycling empty container ship anchored at Shanghai port.

Firstly, we show the statistical graph of the following samples as

Figure 1 The statistical analysis of cycle time

From the above graph, we found: the density of the inland cycling time is possible to be described by the distribution of negative exponent. So we take the statistical test as follows:

The density function of the distribution negative exponent is:

$$f(t) = \frac{1}{\theta} e^{-\frac{t-\eta}{\theta}} \quad (17)$$

As

$$E(t) = \int_0^{\infty} t f(t) dt = \int_0^{\infty} t \cdot \frac{1}{\theta} e^{-\frac{t-\eta}{\theta}} dt = \eta + \theta \quad (18)$$

So we can get:

$$\eta = \eta + \theta \Rightarrow \eta = \theta \quad (19)$$

From the sample data, we work out:

$$\eta = 3.70, \theta = 2, \theta = 1.70, f(t) = \frac{1}{1.70} e^{-\frac{t-3.70}{1.70}} \quad (20)$$

Then we can get the following

Table1: The Result of Statistical

i	f <sub>i</sub>	$\hat{p}_i$	$n \hat{p}_i$	$N \hat{p}_i - f_i$	$\frac{(n \hat{p}_i - f_i)^2}{n \hat{p}_i}$
A <sub>1</sub> : 0 ≤ t < 6.5	23	0.4872	18.0277	-4.9723	1.3714
A <sub>2</sub> : 6.5 ≤ t < 12.5	10	0.3496	12.9351	2.9351	0.6660
A <sub>3</sub> : 12.5 ≤ t < 18.5	3	0.1112	4.1161	1.1161	0.3026
A <sub>4</sub> : 18.5 ≤ t < ∞	1	0.0519	1.9211	0.9211	0.4416
Σ					2.7817

With the above table, we can get:

$$\chi^2_{0.05}(k-1) = \chi^2_{0.05}(3-1) = \chi^2_{0.05}(2) = 3.841 > 1.3402 \quad (21)$$

Based on the above analysis, we conclude that the turnover time of empty container in Shanghai port follows the distribution of the negative exponent.

By using the statistical information of other ports, we can also get the above conclusion. Then we can conclude that the arriving time of the empty container follows the Poisson distribution

It should be noted that in different port, because of the difference of the delivering distance of the inland, the difference of the storing and loading time in the port and the difference of the velocity of collecting and delivering by highway, water and railway, although the extending time of the empty container still follows the distribution of negative exponent, the parameters are different.

#### 4.2 The statistical distribution rule of the container's supply and demand

In the above, we have identified the statistical distribution rule of the inland cycling time, then we can use sample data which was dogged from the database of EDI platform to analyze the distribution rule of the container's supply and demand

Firstly we show the statistical graph of the factor as follows:

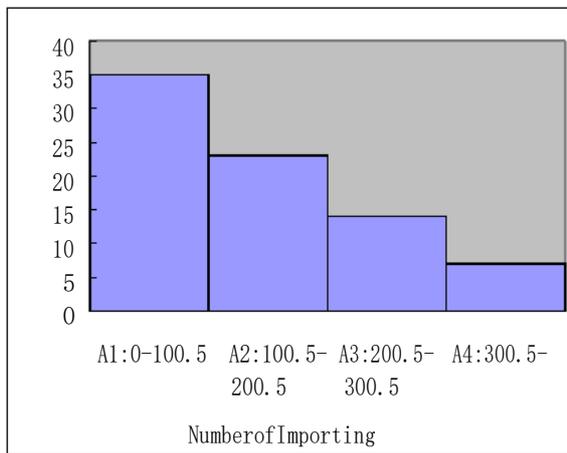
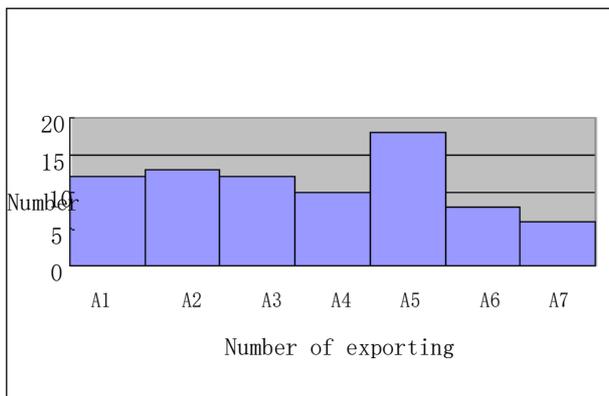


Figure 2 The statistical analysis of importing container



注: A1:0-66.5; A2:66.5-113.5; A3:113.5-160.5; A4:160.5-207.5; A5:207.5-254.5; A6:254.5-301.5; A7:301.5-

Figure 3 The statistical analysis of exporting container

From the above graph, we found: the distribution of importing empty container is resemble the negative exponent and the possible distribution of empty container follows normal distribution. So we take the similar statistical test shown in the above and we found the assumption is correct.

#### 4.3 Conclusion

From the analysis, we can find the following generally speaking, the distribution of empty container demand follows the distribution of normal distribution and that of the turnover of the empty container follows the distribution of negative. It is worthy of pointing out that it has different pattern of the distribution both at different ports and different time. Therefore, when making use of stochastic optimization model, we must get the relative EDI information actually and promptly to get the appropriate distributive pattern.

5. The developing of the decision support system (DSS) for stochastic optimization of the empty container inventory based on shipping EDI information.

Based on the model above, we adopt PB to design the DSS for stochastic optimization of container inventory based on the ports and shipping EDI information.

The system structure can be described as follows:  
(see next page)

In the above system:

The functions of the application level analysis on the container market; the optimization of the container distribution; the analysis on the container index.

The function of the data warehouse is to store the original data digged from the source of the EDI platform.

The function of database is to store some used parameters of the application level.

The function of knowledge base is to store the knowledge used by the application level.

The function of model base is to store the models used by the application level.

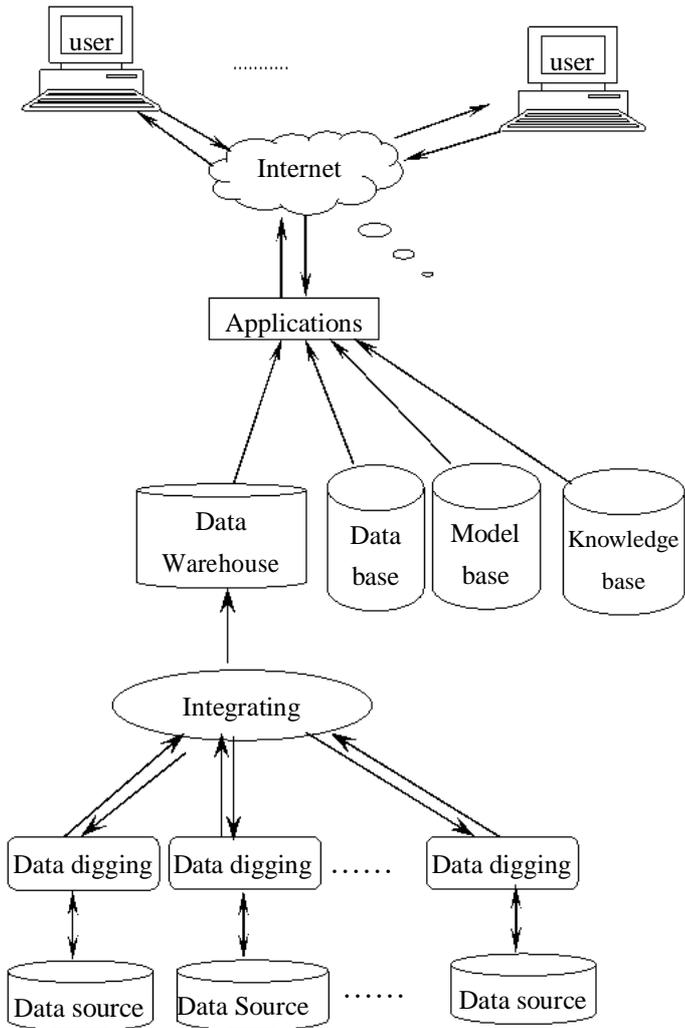


Figure 4 The Structure of DSS

Because of the limitation of time, we only design the structure and function of the whole of the system and start to develop the original system by means of PB. The task of the first phase is to realize stochastic optimization model for the empty container inventory based on EDI information. It includes three functions: digging correlative data from the EDI platform, making statistic analysis to get the distribution pattern and some parameters, and realizing the numeric simulation of the optimization models.

Bibliography:

- [1]Venkat N Gubivada, etc,Information retrieval on the world wide web. IEEE Internet Computing[J], 1997, 1(5): 58—68.
- [2]Shi xin,The simulatuion and optimization of the shipping business process based on Petri net [J]. Journal of System Simulationm, 2001, 13(6):767-780.
- [3]Liu heng jiang, The analysis of collection and allocation of empty containers[J].Containerization 2001,(10),11-13

# A Fuzzy Logic and Genetic Algorithm based Supplier Performance Evaluation Methodology for an Effective Supply Chain

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## Abstract

In this paper, an attempt has been made to evaluate the supplier performance by adopting evolutionary fuzzy system owing to the linguistic nature of the attributes associated with the suppliers and manufacturing units. The proposed methodology provides reasonably good performance when applied to a process industry for evaluation of supplier's performance.

## 1. Introduction

Managing of Supply Chains has gained importance for competing in the business environment in this decade. The objective of the supply chain management is to have the right product at right place at the right time. A supply chain is a network of facilities that procure raw materials, transforms them to intermediate goods and then to finished products, and delivers the products to customers through a distribution system. There are three stages in the supply chain: procurement, production and distribution.

In order to ensure the uninterrupted supply of items, purchasing manager need to periodically evaluate supplier's performance in order to retain those suppliers, which meet their requirement in terms of several performance criteria. The evaluation element typically consists of identifying the attributes, factors relevant to the decision and then measuring each vendor by considering each of the relevant factors.

It is worth to mention here that in some of the recent studies, the essential requirements advocated for suppliers' selections are quality, cost, delivery, flexibility and response [1]. In recent years, several proposals for evaluating the performance of the suppliers have been reported in the literatures. Notable among them: Categorical method, weighted point method, and cost ratio method [2, 3]. Soukep [4] suggests supplier selection strategies using weighted point method. Narasimhan [5] and Tam [6] propose an Analytic Hierarchic Process (AHP) based methodology to supplier selection. Li et al. [7] propose a new supplier performance measure employing the concept of dimensional analysis. They suggest a standardized unitless rating (SUR) by combining the weighted average of qualitative and quantitative scores associated with each supplier. Petroni and Braglia [8] use Principal Component Analysis for Vendor selection. Narasimhan et al [9] propose Data Envelopment Analysis

(DEA) for supplier evaluation and above mentioned methodologies have some advantages under specific condition only. But none offers a generic methodology, which can combine several criteria or attributes into a single measure of supplier performance. Owing to their diverse and linguistic nature, supplier attributes usually need to be categorized prior to further analysis. A cross-functional team is required to rate the supplier' attributes in linguistic descriptions like very low, low, medium, high, very high etc. Linguistic assessment of suppliers is to be carried out based on several criteria, such as quality, response to special orders, delivery performance and price. Because of the imprecise nature of linguistic attributes associated with suppliers, inconsistencies in the judgment are bound to crop up regarding the grading of supplier performance. To deal with these inconsistencies, fuzzy method is suggested to convert the suppliers' linguistic attributes into fuzzy numbers and relative supplier performance is assessed using fuzzy arithmetic.

In this paper, an evolutionary fuzzy system-based methodology is suggested for a more precise and effective assessment and evaluation of suppliers. It maintains a population of fuzzy rule sets with their membership functions, and uses the genetic algorithm to evolve a feasible fuzzy rule base. One of the key considerations in designing the proposed evolutionary fuzzy system is the generation of fuzzy rules as well as the membership functions for each fuzzy set. While dealing with a few input variables, the cross-functional teams are used to generate the fuzzy rules for several performance attributes. Since the number of fuzzy rules increase exponentially with increase in number of input variables, it is difficult for the cross functional team to define a complete fuzzy rule base for a good decision support system. It is essential to develop a genetic algorithm (GA) based methodology to evolve the optimal set of fuzzy rule base. Currently several researchers [10, 11] recommend evolutionary fuzzy systems in the areas of data classification, prediction and control problems.

## 2. Fuzzy System

In many real world applications, fuzzy systems that make use of linguistic rules are aptly suited to describe the behavior of computer systems problem, which is difficult to model mathematically. Fuzzy theorists used fuzzy sets to

represent the non statistical, uncertainty and reasoning to real life data. The membership value  $m_A(x)$  represents the grade of membership of  $x$  in  $A$ . The larger  $m_A(x)$ , stronger the grade of membership for  $x$  in  $A$ . In a  $n$ -input-single-output fuzzy system, the fuzzy rules have the following general format:

$R_j$  : IF  $X_1$  is  $Y_{1,j}$  And  $X_2$  is  $Y_{2,j}$  And ..... And  $X_n$  is  $Y_{n,j}$  Then  $Y$  is  $Z_j$

Where the variables  $X_i$  ( $i = 1, \dots, n$ ) appearing in the antecedent parts of the fuzzy rules  $R_j$  are called the input linguistic variables, the variable  $Y$  in the consequent part of the fuzzy rule  $R_j$  is called the output linguistic variables, the fuzzy sets  $Y_{i,j}$  are called the input fuzzy sets of the input linguistic variable  $X_i$  of the fuzzy rule  $R_j$ , and the fuzzy set  $Z_j$  is called the output fuzzy set of the output linguistic variable  $Y$  of the fuzzy rule  $R_j$ .

A fuzzy expert system is defined if and only if the rule sets and membership functions associated with its fuzzy sets are defined. All the fuzzy rules in a fuzzy system are fired in parallel mode. The working of a fuzzy expert system can be described as follows :

- i) Evaluate the values of fuzzy membership by energizing the inputs
- ii) Obtain the fuzzy rules which are fired in the rule set .
- iii) Adopting AND operator, club the values of membership for each energized rule
- iv) Search rule activation membership values supported by the min-max compositional rule to obtain the appropriate output fuzzy membership value.
- v) Determine the value of each output variable by defuzzification which is carried out by the weighted average method.
- vi) Take decisions according to the output values.

In this paper weighted average method is adopted to defuzzify the fuzzy output data as this methodology is only valid for symmetric output membership function. based on the crisp output data, practical decisions can be made to solve the problems. In this paper based on the crisp output data, the suppliers performance are graded.

### 3. Evolutionary Fuzzy Systems

It has been observed that majority of the existing applications, the fuzzy rules are generated by experts and decision makers conversant with the problem, with only a few inputs. The possible number of fuzzy rules for a given system grows exponentially when the number of input variable increases. For example in the evaluation of a supplier performance with 10 attributes and each attribute consists of 5 linguistic descriptions ( very low, low, medium, high, very high ) then the possible number of fuzzy rules are  $5^{10}$ . It is too difficult if not impossible for an expert to define a complete rule set for assessing the system performance. There are several methods like clustering algorithms, pattern classification methods etc. to practice an automated way to design fuzzy system. These methods are possessing a drawback related to the extractions of rules where it is possible that these rules become the independent of membership functions leading

to degraded performance of the fuzzy system especially in the case of complex system problem with large number of input variables. In several cases, the systems performance are found to be improved by tuning the membership functions and selecting suitable fuzzification and defuzzification methods. In this paper, evolutionary fuzzy system have been employed in which the fuzzy rule set, number of rules inside the rule set are generated using a powerful and intelligent search algorithm known as Genetic Algorithm to assess the supplier performance. Genetic Algorithms have recently found its growing applications in solving the several types of linear and non-linear optimization problem. GA is a matured tool and interested readers are advised to refer Goldberg[12]. This fact motivated the researchers to use this intelligent optimization tool for the generation of a set of fuzzy rules required to design the fuzzy rule base. The various constituents of the proposed evolutionary fuzzy system are described as follows.

#### 3.1 Representation

The first important consideration while designing a fuzzy expert system using GA is the representation strategy adopted to encode the fuzzy system into the chromosome. A fuzzy system is well defined only when the fuzzy rule base and the membership functions associated with each fuzzy set of a variable are specified. Thus, it is practically realized that to completely represent a fuzzy expert system, each chromosome must encode all the requisite information about the rule sets and the membership functions. The fuzzy rules in the rule base and the number of such fuzzy rules that are associated with the problem are to be evolved using GA. In order to reduce the search space, it is advocated that the maximum number of rules concerning any problem is fixed in advance. After performing exhaustive trial and error experimentation, the maximum number of acceptable rules undertaken in this study is limited to 40. Then the total length of the chromosome representing the system is  $1+5*(40)=201$ , and the system can be represented as  $S_1S_2S_3S_4S_5S_6 \dots S_{57}S_{58}S_{59} \dots S_{140}S_{141} \dots S_{199}S_{200}S_{201}$ ,

Where  $S_1$  represents the number of rules varying between 1 and 40,  $S_2, S_3, \dots, S_6$  encodes the first fuzzy rule in the rule set and  $S_{197}, S_{198} \dots S_{201}$  represents the last fuzzy rule in the rule set.  $S_1$  denotes the number of possible rules that are used to design the rule base. However, it is observed that each rule may not be feasible. A rule with a zero antecedent or consequent part is an infeasible rule and should be excluded from the fuzzy rule base. In order to ensure that the chromosome contains no infeasible rules, the fitness value corresponding to the chromosome is assigned to a very small floating number  $[0,1]$ , so that these chromosomes do not pass over to the next generation.

#### 3.2 Fitness Function

While the genotype representation encodes the rule base into a integer string, the fitness function evaluates the performance of the rule base. For prediction and

estimation problems, the mean-square error or difference error related function is most commonly used. In this paper, the mean square error function is determined to evaluate the fitness of the chromosomes.

$$E = 1/N \sum (o_i - e_i)^2 \quad \dots (1)$$

Where N is the number of evolved fuzzy rules.,  
 $o_i$  and  $e_i$  are the  $i^{\text{th}}$  expected outputs obtained by assigning priorities to the input variable

$$\text{Fitness Value} = 1 / (1 + E) \quad \dots (2)$$

Chromosomes with higher fitness value are carried to the next generation.

### 3.3 Crossover Operator

Crossover is a process by which two parent strings recombine to produce two new offspring strings. An overall probability is assigned to the crossover process. Given two parent chromosomes, the algorithm invokes crossover only if a randomly generated number in the range of 0 to 1 is greater than crossover rate ( it is also known as crossover probability), otherwise the strings remain unaltered. This probability is often in the range of 0.65-0.80.

### 3.4 Mutation Operator

After crossover, normally strings are subjected to mutation. Mutation operator randomly alters few composition of a string to produce a new offspring instead of recombining two strings. In a traditional genetic algorithm, mutation of a bit involves flipping it : changing a "0" to "1" or vice versa. It is found that the chromosome representing the fuzzy expert system is integer based instead of binary based i.e., each element of the string has an integer range representing the various states of the variable ( input / output ). The mutation operator used is thus a bit different than that used in binary encoding. Each time an element is chosen to be mutated, it is increased or decreased by replacing it by an integer in the range[ 1, 5] excluding the present value of the element . The integers of the string are independently mutated i.e., the mutation of the element does not influence the probability of mutation of another element.

## 4. Computational Exercise

The supplier performance is graded based on the attributes, which were selected from both the supplier and product's view point. They are namely quality rating, delivery performance, price rating, and service rating. In order to evolve the fuzzy rule base using Genetic Algorithms, a good fitness function is essential. Here, a least mean square function is adopted for fitness measurement, where the expected outputs are determined by prioritizing the attributes. Each feasible fuzzy rule that is evolved in the rule base has the maximum prioritized attribute in the first position, the next prioritized attribute in the second position and like wise. These priorities are analogous to weightages that are assigned to the attributes and reveals the relative importance among themselves. The fuzzy membership functions associated with the fuzzy sets of each inputs are left-triangle, triangle, triangle,

triangle, and right-triangle corresponding to the description very low, low, medium, high and very high.

The ranges and the overlap area of the membership functions are fixed. A triangular fuzzy membership function has been adopted for the representing the fuzzy sets of the output variable.

## 5. Conclusions

Supplier performance evaluation is one of the important ingredients for the successful implementation of the strategies of supply chain. Several recent studies with regard to suppliers performance were critically examined. A novel methodology based on the fuzzy logic and genetic algorithm is employed to assess the performance of supplier.

## References

1. Willis TH, Huston CR, Pohlkamp F. Evaluation measure of just-in-time Supplier performance. *Production and Inventory management Journal* 1993.
2. Dobler DW, Lee L Jr, Burt DN. *Purchasing and Materials Management: Text and Cases*. 5<sup>th</sup> edn, McGraw Hill, NewYork, 1990.
3. Timmerman E. An approach to vendor performance evaluation. *Journal of purchasing and Materials Management* 1986; 22(4): 2-8.
4. Soukup WR. Supplier selection strategies. *Journal of Purchasing and Materials Management* 1997; 23(2): 7-12.
5. Narasimhan R. An analytical approach to supplier selection. *Journal of Purchasing and Materials Management* 1983; 19(4) : 27-32.
6. Tan, M.C.Y. and Tummala, V.M.R. An application of AHP in Vendor selection of a telecommunications system. *Int. Journal of Omega* 2001, 29, 171-182.
7. Li CC, Fun YP, Hung JS. A new measure for Supplier performance evaluation. *IIE Transactions* 1997;29:753-758.
8. Petroni, A. and Braglia, M. Vendor selection using Principal Component Analysis. *The Journal of Supply Chain management*, Spring 2000, 63-69.
9. Narasimhan, R., Talluri, S. and Mendez, D. Supplier evaluation and rationalization via Data Envelopment analysis: An empirical Examination. *The Journal of Supply Chain management*, summer, 2001, 28-36.
10. Wang CH, Hong TP, Tseng SS. Integrating Fuzzy Knowledge by Genetic Algorithms. *IEEE Trans. On Evolutionary Computation* 1998; 2(4): 138-149.
11. Yuan Y, Zhuang H. A genetic algorithm for generating fuzzy classification rules. *Fuzzy Sets Syst.* 1996 ;84 :1-19.
12. Goldberg DE. *Genetic Algorithm in search. Optimization and Machine Learning*. Addison Wesley Reading MA 1989.

# Inventory Policy Implications of On-Line Customer Purchase Behavior

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## Abstract

In this paper we will examine some implications of online data for a classical operations management model, vis. the Economic Order Quantity model. Customer waiting behavior on individual orders (which occur during stockouts) forms the basis for evaluating the potential backorders. The potential attraction of reducing inventory holding costs must be balanced with the loss due to lost sales. We clearly delineate the conditions under which it is profitable to stock out every ordering cycle, and the conditions under which the traditional economic order quantity model still holds. In order to allow practical application of the model, we develop a number of different approaches to the problem of estimating the backorder function from available on-line transaction data.

## 1. Introduction

The emergence of web based online retailing has changed the manner in which customer behavior can be tracked and profiled. A recent article profiling Yahoo presents the potential and pitfalls in utilizing this data for new business models [10]. New tools are available that allow one to target promotions and product offerings to customers predisposed to purchasing them as indicated by customers' observed past behavior.

The availability of extensive customer purchase behavior data is changing the way in which different functional areas can formulate optimal tactics and strategies. This has particular relevance for marketing. For instance; Active Buyers Guide helps visitors select models of various consumer electronic items (see <http://www.activebuyersguide.com>). They evaluate the customer's preferences for attributes by conducting a factor analysis using dynamically generated flash card comparisons. Similarly, in retailing, some sites track the online browsing behavior and have a history of items that a particular customer finds interesting. This data is used to suggest similar items for purchase. Amazon (<http://www.amazon.com>) is a popular retailer with extremely sophisticated customer management. "What Amazon.com has done is invent and implement a model for interacting with millions of customers, one at a time" (see [1]). "Customers love Amazon not because it offers the lowest prices--it doesn't--but because the experience has been crafted so carefully that most of us actually enjoy

it" (see [6]).

There are implications for inventory management as well. As an example, this data is also being used to suggest alternate items in case a particular item is out of stock, or to provide an updated estimate for the waiting time till new stock arrives. This allows the customer to make informed choices about substitution and/or backordering. This behavior is now visible to the retailer, and can form the basis for better business decisions. The challenge is not merely to suggest replacement items or provide waiting times, but to use operational policies and management strategies to better support this interaction between the firm and the customer.

In this paper we will examine some implications of online data for a classical operations management model, vis. the Economic Order Quantity model. Customer waiting behavior on individual orders (which occur during stockouts) forms the basis for evaluating the potential backorders. The potential attraction of reducing inventory holding costs must be balanced with the loss due to lost sales. We clearly delineate the conditions under which it is profitable to stock out every ordering cycle, and the conditions under which the traditional economic order quantity model still holds. In order to allow practical application of the model, we develop a number of different approaches to the problem of estimating the backorder function from available on-line transaction data.

## 2. Literature Survey

There is a significant body of recent literature on online retailing. The increasing popularity of the web has led to an explosion of research related to retail substitution behavior (see [2] [3] [8] [14] [21]). These papers illustrate the effect of detailed customer behavior data on the Operations Management literature.

The EOQ formula was initially derived in [11], and the related literature is voluminous, see e.g. [9] [23]. The EOQ model with backorders has been discussed by [9] as well. They consider a linear backorder function, and derive a policy based on a backorder cost per unit backordered per time unit.

A number of authors have extended the EOQ model by considering backorders. Backorder models where only a fraction of the demand is backordered when a stockout occurs are examined in [15] [16] [20] [22]. Our model easily handles these kinds of mixtures between backorders

(pent-up demand) and lost sales. Our model does not have explicit costs of not satisfying demand from on-hand stock. Instead, some of the demand during the stockout period turns into lost sales, which reduces revenue for the retailer.

Backorders have been the subject of extensive research in the context of stochastic models. An order point order quantity model with a mixture of backorders and lost sales is investigated in [18]. Lost sales will occur when backorders exceed a certain threshold level. General backorder costs in stochastic inventory models are discussed in [5].

The cost structure of backorders has been extended by some authors. Inventory policies when the backorder costs have fixed and proportional components are examined in [4]. Another approach to modeling the effect of stock-outs can be found in [17], where it is assumed that the demand rate is influenced by backorders. However, to the best of our knowledge, the approach to modeling the effect of stockouts presented in our model is new, as is the characterization of conditions under which periodic availability is an optimal policy.

There is also extensive research on perishable inventories, when the stock at hand may decay, or become obsolete. One representative paper [13] integrates the stocking decision with backordering. While we do not have perishable inventories, we have “perishable” backorders, in the sense that backorders grow less than proportionately with the elapsed stockout time.

Finally, in [12] a recent paper uses an exponential pent-up demand function in the context of stochastic lead times. Lee focuses on algorithms to obtain the optimal stockout period without deriving any structural results. This is the only paper we have found so far which examines a non-linear pent-up demand function. In contrast, our paper presents the structural results for any pent-up demand function, as well as the parametric conditions under which three different policies are optimal: the EOQ stocking policy, the periodic stocking policy and the no-inventory policy.

Many EOQ inventory models focus on inventory as a cost, as the original work [11] did. The decision maker controls a cost center, and attempts to minimize costs while delivering a certain service level. Often, this leads to situations where the optimal decision is unprofitable, as already observed in [22]. In contrast, our objective is to maximize profits, which allows us to choose not to operate if it is not profitable.

A different way to think of the periodic availability policies in this paper is as a bridge between classical “supply from inventory” policies (where a retailer attempts to fill demand from on-hand stock) and stockless retailing policies (where the retailer acts purely as an order taker who passes the demand on to his supplier). Indeed, both extremes are special cases of our general model.

We use fractional programming to solve the discounted cash flow optimization. A good introduction to non-linear fractional programming can be found in [7]. Our

algorithm is similar, but specifically crafted for our needs.

### 3. The Inventory Model

We make all the standard assumptions of the Economic Order Quantity (EOQ) model, but with some additional assumptions regarding what happens when the retailer runs out of stock (which is not allowed in the EOQ model). The retailer experiences a constant deterministic demand of  $D$  units of product per unit time for a given product. The retailer can place an order at any time for any quantity of product desired, and the delivery will be made after a constant lead time. There is a fixed order cost of  $F$  per order placed, a purchasing cost of  $c$  per unit purchased, non-financial inventory holding cost of  $h$  per unit kept in inventory per unit time, and since we will use continuous time discounting, a discount rate of  $r$  per time unit. The retailer sells items at a price of  $p$  per unit sold. The retailer seeks to maximize total discounted profit.

Contrary to the standard EOQ assumptions, we assume that when the retailer runs out of stock, some of the demand is backordered and some of the demand is lost. In particular, if the retailer has been out of stock for  $t$  time units, the total “pent-up” or backordered demand equals  $\bar{D}(t)$ . The function  $\bar{D}(t)$  is assumed to satisfy the following properties:  $\bar{D}(0) = 0$ ,  $\bar{D}(t)$  is concave and non-decreasing, and  $\bar{D}(t) - \bar{D}(s) \leq (t - s)D$  for all  $t > s \geq 0$ . Of course if  $\bar{D}(t)$  is differentiable, these conditions can be stated as  $0 \leq \bar{D}'(t) \leq D$ , and  $\bar{D}'(t)$  is non-increasing. It will be convenient to use a scaled version of the pent-up demand function, so we define  $k(t) = \bar{D}(t)/D$ . This function will therefore satisfy the following assumptions:

$$k(0) = 0,$$

$k(t)$  is non-decreasing and concave.

Define the subdifferential  $\partial k(t)$  of  $k$  at  $t$  as the set of all values  $x$  such that  $k(s) \leq k(t) + x(s - t)$  for all  $s \geq 0$ . In particular the assumptions imply that  $k$  is almost everywhere differentiable, and that the subdifferential  $\partial k$  always exists and is decreasing in the obvious sense, i.e., if  $t < s$ , then  $k'(t) \geq k'(s)$  for every  $k'(t) \in \partial k(t)$  and  $k'(s) \in \partial k(s)$ .

Using standard dynamic programming arguments, it is easy to see that a cyclic policy is optimal. For convenience, we will assume that the retailer starts with no stock, and with no backorders. The retailer must then decide, first, how long to allow backorders to build up before taking delivery ( $t$ ), and second, how long ( $x$ ) to keep the item in stock after that. Either of these time periods can be zero: if  $t = 0$ , the classical EOQ situation results, if  $x = 0$ , the retailer follows a “stockless” policy, i.e., the retailer is basically just an order taker.

Hence during a single cycle the following events occur. At time 0 (the start of the cycle), the retailer runs out of stock. Pent-up demand accumulates during the next  $t$  time units. At that moment, an order of  $Q$  units of product is received. The pent-up demand  $\bar{D}(t)$  is satisfied as soon as the delivery of product is made at time  $t$ , so the resulting

inventory is  $Q - \bar{D}(t)$ . Note that it doesn't make sense to not satisfy all the pent-up demand at time  $t$ : the retailer could just order  $\bar{D}(t) - Q$  more units and sell them immediately at time  $t$ . This would lead to a positive cash flow of  $(p - c)(\bar{D}(t) - Q)$  at time  $t$ . If this pent-up demand is not satisfied at time  $t$ , some of it may turn into lost sales, and the net present value of the remainder is reduced because of discounting.

During the interval  $(t, t + x)$ , the inventory of  $Q - \bar{D}(t)$  is drawn down at a rate of  $D$  by the regular demand, and at time  $t + x$  the retailer runs out of stock again. Hence

$$x = (Q - \bar{D}(t)) / D = Q/D - k(t) \quad (1)$$

or 
$$Q = D(x + k(t)). \quad (2)$$

Finally, to avoid pathological cases, we assume  $p > c \geq 0$ ,  $F > 0$ ,  $h > 0$ .

#### 4. The Optimal Inventory Policy

We first derive an expression for the net present value associated with a policy  $(x, t)$ . We assume that at time 0 the retailer runs out of stock. Then during the interval  $(0, t)$  there are no cash flows. At time  $t$ , the retailer purchases  $D(x + k(t))$  units of product at discounted cost  $e^{-rt}(cD(x + k(t)) + F)$ . At the same time, the retailer sells  $Dk(t)$  units with a discounted revenue of  $e^{-rt}pDk(t)$ . During the interval  $(t, t + x)$  the retailer sells  $D$  units of product per time period, which leads to total discounted revenue of

$$pD \int_t^{t+x} e^{-ry} dy = p \frac{D}{r} e^{-rt} (1 - e^{-rx}).$$

During this time interval inventory decreases from  $Dx$  to 0, which means that the discounted holding cost over this period equals

$$hD \int_t^{t+x} (t + x - y) e^{-ry} dy = h \frac{D}{r} e^{-rt} (x + \frac{e^{-rx} - 1}{r}).$$

Define  $\alpha = D(p - c)$ ,  $\beta = (D/r)(p + h/r)$ , and  $\gamma = (D/r)(c + h/r)$ . Then the discounted value of all cash flows during the first cycle can be expressed as

$$e^{-rt} (\alpha k(t) - F - \gamma rx + \beta(1 - e^{-rx})).$$

Finally the total discounted value of all cash flows for an infinite horizon is the single cycle value multiplied by  $1/(1 - e^{-r(t+x)})$ , which equals

$$\pi(x, t) = \frac{\alpha k(t) + \beta(1 - e^{-rx}) - \gamma rx - F}{e^{rt} - e^{-rx}}. \quad (3)$$

It is not hard to show that in maximizing (3) we can confine ourselves to the region

$$\Psi = \{(x, t) : x \geq 0, t \geq 0, (x, t) \neq (0, 0)\}$$

Hence we want to find

$$G^* = \sup \{\pi(x, t) : (x, t) \in \Psi\} \quad (4)$$

Define the function

$$f(x, t, G) = \alpha k(t) + \beta(1 - e^{-rx}) - \gamma rx - F - G(e^{rt} - e^{-rx}),$$

then we can write

$$G^* = \sup \{G : f(x, t, G) = 0, (x, t) \in \Psi\}. \quad (5)$$

We will exploit the fact that  $f$  is (jointly) concave in  $x$  and  $t$  to develop an efficient algorithm for solving problem (4).

Before we can characterize the optimal policy, we need some lemmas.

**Lemma 1**  $G^* < \beta - \gamma$ .

Proof: First, note that for all  $t \geq 0$  we have

$$\alpha k(t) \leq \alpha t = (\beta - \gamma)rt \leq (\beta - \gamma)(e^{rt} - 1),$$

and for all  $x \geq 0$  we have

$$\beta(1 - e^{-rx}) - \gamma rx \leq (\beta - \gamma)(1 - e^{-rx}),$$

hence for every  $(x, t) \in \Psi$  we have

$$\pi(x, t) \leq \frac{(\beta - \gamma)(e^{rt} - e^{-rx}) - F}{e^{rt} - e^{-rx}} < \beta - \gamma. \quad \square$$

**Lemma 2** Let  $0 < G < \beta - \gamma$ . The problem

$$z_G = \max \{f(x, t, G) : x \geq 0, t \geq 0\} \quad (6)$$

has a unique solution  $(x_G, t_G)$  given by

$$rx_G = \ln(\beta - G) - \ln \gamma, \quad (7)$$

$$0 \text{ if } \alpha k'(0) \leq rG,$$

$$t_G = \text{the unique value } t \text{ for which} \quad (8)$$

$$\alpha k'(t) = rGe^{rt} \text{ otherwise.}$$

(If  $k$  is not continuously differentiable, then  $k'(t)$  should be interpreted as a suitably chosen subdifferential of  $k$  at  $t$ ).

Proof: Note that  $f$  is separable in  $x$  and  $t$ . It is thus straightforward to show that  $f$  is jointly concave in  $x$  and  $t$ , and that (7) and (8) are the first order conditions for a global maximum.  $\square$

**Lemma 3** Let  $0 < G < \beta - \gamma$ . Then

$$\text{sign}(z_G) = \text{sign}(G^* - G).$$

Proof: We consider the obvious three cases separately.

**Case 1:**  $z_G > 0$ . Define  $\varepsilon = z_G / (e^{rt_G} - e^{-rx_G}) > 0$ , then  $f(x_G, t_G, G + \varepsilon) = f(x_G, t_G, G) - \varepsilon(e^{rt} - e^{-rx}) = 0$ , and hence  $G^* \geq \pi(x_G, t_G) = G + \varepsilon > G$ .

**Case 2:**  $z_G = 0$ . Then  $f(x_G, t_G, G) = 0$ , and since  $f(0, 0, G) = -F < 0$ , this implies  $(x_G, t_G) \neq (0, 0)$ , so  $(x_G, t_G) \in \Psi$  and  $G^* \geq \pi(x_G, t_G) = G$ . Furthermore, for arbitrary  $(x', t') \in \Psi$  we know  $f(x', t', G) \leq 0$ , and since  $f$  is strictly decreasing in  $G$  on  $\Psi$ , this implies by (5) that  $G^* \leq G$ . We conclude that in this case  $G^* = G$ .

**Case 3:**  $z_G < 0$ . We need to show  $G^* < G$ . If  $G^* \leq 0$ , we are done, since the lemma assumes  $G > 0$ . So assume  $\varepsilon = \pi(x', t') > 0$  for some  $(x', t') \in \Psi$ . We will next show that  $\Phi = \{(x, t) \in \Psi : \pi(x, t) \geq \varepsilon\}$  is compact. Note  $\Phi = \{(x, t) \in \Psi : f(x, t, \varepsilon) \geq 0\}$ , and since  $f(0, 0, \varepsilon) = -F < 0$ ,  $\Phi = \{(x, t) : f(x, t, \varepsilon) \geq 0, x \geq 0, t \geq 0\}$ . Since  $f$  is continuous in  $x$  and  $t$ , it follows that  $\Phi$  is closed. Using that  $f$  is separable and concave and that  $f$  tends to  $-\infty$  when either  $x$  or  $t$  tends to  $\infty$ , it is not hard to show that  $\Phi$  is bounded. Hence

$$G^* = \sup \{ \pi(x, t) \mid x \in \Psi \}$$

$$= \sup \{ \pi(x, t) \mid x \in \Phi \}$$

$$= \pi(x^*) \quad \forall t$$

for some  $(x^*, t) \in \Psi$ . But since  $x^* \leq z_0 < 0$ , this implies  $x^* < G$ .

The three cases together imply the lemma.

**Lemma 4** Define  $k(\infty) = \lim_{t \rightarrow \infty} k(t)$ , then

$$k(\infty) + \beta - \gamma(1 - \beta) > F \Leftrightarrow G^* > 0. \quad (9)$$

**Proof:** Note  $f(t) = k(t) - \beta - \gamma(1 - \beta)$  for every  $t \in \Psi$ , and that the bound is tight (easily shown using the same approach as the proof of Lemma 2). Hence if the condition on the left in (9) is true, there exists a  $t \in \Psi$  such that  $f(t) > 0$ . But this implies  $\pi(x^*, t) > 0$ . If on the other hand the condition on the left in (9) is false, then for every  $t \in \Psi$ ,  $f(t) \leq 0$ , and this implies  $G^* \leq 0$ .

**Theorem 1** If  $k(\infty) + \beta - \gamma(1 - \beta) > F$ , then the optimal policy  $(t^*, x^*)$  satisfies

$$t^* = \frac{1}{r} \ln \left( \frac{\beta - G^*}{\gamma} \right), \quad (10)$$

$$x^* = \begin{cases} \frac{1}{\gamma} \ln \left( \frac{\beta - G^*}{\gamma} \right) & \text{if } \beta - \gamma k'(0) > G^* \\ 0 & \text{otherwise} \end{cases} \quad (11)$$

$$k(t^*) - G^* e^{rt^*} + \beta - \gamma F - \gamma \ln \left( \frac{\beta - G^*}{\gamma} \right) = 0. \quad (12)$$

If  $k(\infty) + \beta - \gamma(1 - \beta) \leq F$ , then  $G^* = 0$  (i.e., it is optimal never to purchase the item).

**Proof:** Lemmas 2 and 3 imply that the values  $t^*$  and  $x^*$  satisfy equations (10), (11)

$$k(t^*) - G^* e^{rt^*} + \beta(1 - e^{-rx^*}) + G e^{-rx^*} - \gamma r x^* - F = 0.$$

Substituting (10) into this last equation gives (12). The statement follows from lemma 4 and the fact that  $k(t) \rightarrow \infty$  as  $t \rightarrow \infty$  for any fixed  $x$ .

Theorem 1 gives exact optimality under the conditions:

**Corollary 1** Assume  $k(\infty) + \beta - \gamma(1 - \beta) > F$ , and let  $G$  satisfy the equation

$$G + \gamma \ln \left( \frac{\beta - G}{\gamma} \right) = \beta - \gamma F, \quad (13)$$

then  $t^* = 0$  if and only if  $k'(0) \leq \frac{1}{\alpha} G$ .

Corollary 1 gives the precise conditions under which the classical EOQ policy (of not planning to run a stock) is optimal. Theorem 1 inspires the following efficient algorithm to identify the optimal policy and its notation.

define  $f(t) = k(t) - \beta - \gamma \ln \left( \frac{\beta - G}{\gamma} \right) - \gamma F$ ,

**Algorithm A:**

IF  $\lim_{t \rightarrow \infty} \hat{f}(t) \leq 0$  THEN

$$t^* = \infty; G^* = 0$$

ELSEIF  $\hat{f}(0, \beta - \gamma) k' < 0$  THEN

let  $x^*$  be the unique solution to the

$$t \text{ equation } \hat{f}(t, \beta - \gamma) e^{-rt} - k'(x^*) = 0 \quad (14)$$

(if  $k$  is not differentiable, is a

chosen  $k(x)$  gradient of  $k$  at suitably

$$x^* := (\beta - \gamma) e^{-rt} - k'(x^*)$$

ELSE  $t^* = 0$ ;

$$t^* = 0;$$

let  $G^*$  be the solution to the equation

$$\hat{f}(G^*, G^*) = 0 \quad (15)$$

END IF

$$x^* = \frac{1}{r} \ln \frac{\beta - G^*}{\gamma}$$

To prove the correctness of the algorithm, we need the following technical lemma.

**Lemma 5** The function  $h(t) = \hat{f}(t, \beta - \gamma) e^{-rt} - k'(x)$  is increasing in  $t$ , and by appropriate choices of  $x$  all values  $\hat{f}(0, \beta - \gamma) k'$  and  $\lim_{t \rightarrow \infty} \hat{f}(t, 0) \leq 0$  as  $t$  varies from  $\emptyset$  to  $(0)$ .

**Proof:** Note that we can

$$\text{write } h(t) = h_1(t, k_3(t_2)) - h_2(t, k_3(t_2)) \quad (16)$$

where  $(t, k_3(t))$

$$h_1(t) = \alpha \left( k(t) - \frac{1 - e^{-rt}}{r} k'(x) \right) - \gamma F,$$

$$h_2(t, k_3(t)) = \frac{1}{\gamma} (\beta - (\beta - \gamma) e^{-rt} - k_3(t)),$$

$$h_3(x) = \gamma(x - \frac{1}{r} \ln \frac{\beta - G^*}{\gamma})$$

Note that  $h_2(t, k_3(t))$  is increasing in  $t$ , and it can all values between  $\beta - (\beta - \gamma) k'(0) \gamma \geq 1$  and  $\beta - \gamma$  by

choosing appropriate values for the subgradient  $k_3(t)$ .

Note also  $h_3(x)$  is increasing in  $x$ . We can conclude that the second term of (16) is increasing

can't assume all values  $h_3(t) = (0, k_3'(0))$

between  $\beta - \gamma$  and  $\beta - \gamma k_3'(0)$ .

Next, we will show  $h_1(t, k_3(t))$  is increasing in  $t$

what. Choose  $x \geq 0$ . Note that the concavity

implies that  $-k(s) \geq -k(t)$  and  $s k'(s) \leq t k'(t)$

for every choice of subgradients  $k'$  of  $k$  at  $s$  and  $t$ .

Hence  $\frac{1}{\alpha} h_1(s, k_3(t)) - (h_1(t, k_3(t)))$

$$= k(s) - \frac{e^{-rs}}{r} k'(s) - \left( k(t) - \frac{e^{-rt}}{r} k'(t) \right)$$

$$\geq (s - t) \left( k'(t) - \frac{e^{-rs} - e^{-rt}}{r} k'(s) \right)$$

$$= (s - t) e^{-rt} \frac{1 - e^{-r(s-t)}}{r(s-t)} (s - t) k'(s)$$

$$\geq (s - t) (1 - e^{-rt}) k'(s) \geq 0,$$

where the next to last inequality follows  $x \leq x$

for all  $x$ . Hence  $h_1(t, k_3(t))$  is increasing in  $t$  and

all values between  $\beta - \gamma$  and  $\beta - \gamma k_3'(0)$  (inclusive) and

$k(\infty) - \gamma - F$  (the latter value possibly excluded).

**Theorem 2** Algorithm A correctly solves problem (4).

**Proof:** The IF condition of the algorithm is satisfied under which the retailer can't make a profit on the item (see the last part of theorem 1). So  $G_* = 0$  if it is satisfied. Define  $G = (\beta - \gamma)k'(t)$  and  $x_i = (\ln(\beta - \gamma)k'(t)) / \gamma$ , and the ELSEIF condition of the algorithm is  $z_i < 0$  which is equivalent to  $G < 0$  by lemma 3. Hence if the ELSEIF condition is satisfied,  $G_* = (\beta - \gamma)e^{-\gamma t} / k'(t)$  by (11) and substituting (12) gives  $t$  (14). If  $t \neq 0$  by (11) and substituting this into (12) gives (15). Finally, lemma 3 guarantees that (14) has a unique solution where (1) needs to be solved, and it is easy to show that (15) holds for (15).

A few comments are in order. First, note that the optimality of planned stockouts (the ELSEIF test of the algorithm) depends only on  $k$  the fraction of demand that is not immediately lost at the moment the retailer first stock. The condition is always satisfied when  $\theta < 1$ , so some stockouts will always be optimal. In the other hand,  $\theta > 1$ , the optimality of having some stockouts depends on the value of the fixed order costs  $F$ , and for small enough values of  $F$  it will be optimal to avoid stockouts altogether. When the IF and ELSEIF tests in the algorithm actually coincide (note  $\theta = 0$  implies  $k(t) = 0$  since  $k$  is normalized, non-concave) and hence either the retailer doesn't sell at all or he wants to avoid stockouts altogether.

The decision on whether to sell the item at all (the IF the algorithm) depends only on the maximum (normalized) fraction of demand that is not sold when the retailer has no stock for a very long time. The specific form of the function  $k$  plays a very important role in making these basic decisions. Of course in order to get an optimal stocking policy in the case that planned stockouts are optimal, more information about the demand function is necessary. Note that equation (15) can be solved using Newton's method to find the unique solution of the equation  $\gamma = \ln \gamma - \gamma$  (a convenient starting point is  $\gamma = +1$  (if  $\gamma > 2$ , the solution to the equation obtained approximately  $1 + \frac{1}{2}(\gamma - 1)^2$ ), and from calculating  $\gamma = \beta - \gamma_*$ . Equation (14) can of course be solved using bisection. When  $k$  is differentiable, the conditions which the LHS of (14) is concave involve the derivative of  $k$ , so a simple implementation of Newton's method is not recommended.

When  $k$  is piece-wise linear, the LHS of (14) is in fact convex between breakpoints of  $k(t)$ , while it is concave in

$k'(t)$  at the breakpoints. Hence once the segment which contains  $t$  has been identified, a set of Newton-Raphson steps will quickly yield the solution with great accuracy.

## 5. Estimating the backorder function

In this section we turn to the issue of modeling the backorder function. In particular, one needs to backorder the function. We will sketch a number of approaches to this estimation problem that could be used in various circumstances. Assume that a web retailer uses a web site that provides potential customers with information on how long it will be until the retailer can ship the product. Customers place an order for one unit of the product which will be shipped as soon as it becomes available, for they exit without ordering. The retailer collects the following information related to a particular product of interest. Over a period of  $M$  days, the retailer responded to  $n_i$  inquiries that the shipping delay is  $i$  days, and these  $n_i$  sales would be  $s_i$ . Note that even when the product is available for some potential customers still don't place an order. From this data we wish to estimate the underlying demand rate and the (scaled) pent-up demand function  $k(t)$ . We assume that inquiries are generated according to some stationary process with a rate  $\lambda$  per day. Let the random variables  $S_{ij}$  denote the number of units resulting from the  $j$ -th inquiry that occurs when the shipping delay is  $i$  days. We assume  $S_{ij}: j = 1, 2, \dots$  are iid random variables with mean  $\tau_i$ . If  $\tau_i$  for  $i = 0, \dots, N$  are available, one can estimate the pen-up demand function by linear interpolation on these estimates:

$$\hat{k}(t) = \frac{1}{\tau_0} \sum_{i=1}^N \tau_i \cdot \mathbb{1}_{[i, i+1)}(t), \quad i = 0, 1, 2, \dots, N.$$

The straightforward approach to estimating the average number of units sold per inquiry as a function of the number of days until shipment is of course

$$\tau_i^{naive} = s_i / n_i.$$

The problem with this approach is that the resulting pent-up demand function need not be concave, since it is possible that in the available data  $s_j > i$ . Of course it is counter-intuitive (to at least) that a longer shipping delay would lead to a higher number of units sold per inquiry, so we require that our estimates satisfy  $0 \leq \tau_N \leq \tau_{N-1} \leq \dots \leq \tau_0 \leq 1$ .

In the remainder of this section we discuss several ways to handle this estimation problem.

### 5.1 Parameter Estimation from a Functional Form

The exponential pent-up demand function is given by

$$\bar{D}(t) = \frac{\theta}{\kappa} (1 - e^{-\kappa t}).$$

This form arises if we assume that pent-up demand satisfies the differential equation  $\dot{p} = \theta - \kappa p(t)$  with starting condition 0. Here  $\theta$  is the rate at which pent-up demand dissipates (e.g. because it is satisfied by a competitor or because it is required by consumers), and the fraction of pent-up demand that is not immediately available to radioactive decay. It is not hard to show that the exponential demand-up function satisfies our assumptions. To the complete, we have  $k(\infty) = \theta/\kappa$ ,  $k'(t) = \theta(1 - e^{-\kappa t})/\kappa$ , and  $k'(0) = \theta$ .

A simple approach to estimating values and this to minimize the squared sum of errors between the calculated using the naïve  $\hat{p}_i^{naive}$  and the values of  $k$  estimated with the specified functional form is the logarithmic function given by  $\bar{D}(t) = \frac{\theta}{\kappa} \ln(1 + \kappa t)$ .

It is easy to verify that this implies  $k(t) = \frac{\theta}{\kappa} \ln(1 + \kappa t)$ ,  $k(\infty) = \frac{\theta}{\kappa}$ ,  $k'(t) = \frac{\theta}{1 + \kappa t}$ , and  $k'(0) = \theta$ .

5.2 The Customer Utility Approach

Define the average residual  $\bar{U} = \bar{U} - p$ , where  $\bar{U}$  is the utility that the average customer derives from the item if it is immediately available, and  $p$  is the purchase price. In addition, a customer has a waiting time for the item, so let  $b(x)$  be the backorder cost if the customer has to wait  $x$  time units. Then a customer decides to purchase the item if and only if  $R - b(x) \geq 0$ , where  $R$  is a customer specific variable with mean 0, and  $x$  is the time the customer has to wait for the item. For specific functional forms, one can use probit or logit regression to estimate  $\Pr(R + \epsilon \geq 0)$ , and the normalized pent-up demand function is calculated as  $k(t) = \int_0^t \Pr(\epsilon > b(x) - \bar{R}) R$ .

Clearly, since  $\epsilon > b(x) - \bar{R}$  is non-increasing in  $x$ ,  $k(t)$  cannot exceed the value of 1, and the resulting function satisfies the standard assumptions of section 2. If the function  $b(x)$  is assumed to be linear, then the estimation leads to  $k(t) = \frac{1}{\kappa} [\Phi(-v) - \Phi^1(\kappa t - v)]$ ,  $k'(t) = \Phi(\kappa t - v)$ ,  $k'(0) = \Phi(-v)$ , and  $k(\infty) = \frac{1}{\kappa} \Phi(-v)$ .

where  $\Phi$  denotes the standard normal cumulative distribution function,  $\Phi(y) = \int_{-\infty}^y \phi(z) dz$  is the familiar standard normal linear loss function (see page 458),  $v$  and  $\kappa$  are parameters obtained from the probit regression. Clearly, the estimated parameter

If the function  $b(x)$  is assumed to be linear, then the estimation leads to  $k(t) = \frac{1}{\kappa} [\ln(1 + e^v) - \ln(1 + e^{v - \kappa t})]$ ,  $k'(t) = 1/(1 + e^{v - \kappa t})$ , and  $k(\infty) = \frac{1}{\kappa} \ln(1 + e^v)$  where  $v$  and  $\kappa$  are parameters obtained from the regression and again we need be positive.

The utility approach has as additional advantages on our correct for price changes (and possibly environmental factors) in the estimation, as well as something about the impact of price changes (and additional environmental factors) on optimal policy, profit,

5.3 Piecewise Linear Approximation Using Isotonic Regression

We can use a constrained maximum-likelihood approach to obtain  $\hat{\tau}$  for the  $\tau$  that satisfies the constraints  $0 \leq \tau_1 \leq \tau_2 \leq \dots \leq \tau_n \leq 1$ . This amounts to finding the isotonic regression of the points  $(t_i, n_i)$  with  $n_i$  (see [19, p. 32]). The result is a piecewise linear approximation with breakpoints  $t_0 = 0 < t_1 < \dots < t_n$ , and slopes  $1 \geq \theta_1 > \theta_2 > \dots > \theta_n \geq 0$ . If we define  $\tau_j = t_j$  for any  $t \geq 0$ , then  $\max_{\tau} \{ \dots \}$

$k(t) = \sum_{j=0}^{j(t)} (\tau_{j+1} - \tau_j) \theta_j$

$k'(t) = \theta_{j(t)}$  if  $t \neq \tau_{j(t)}$

$\partial k(t) = [\theta_{j(t)}, \theta_{j(t)+1}]$  if  $t = \tau_{j(t)}$

6. Implications

For on-line retailers, this is an ideal example of their opportunity to inventory management policies in the context of customer behavior. Most sites already have the technology to collect extremely detailed data about the shopping behavior of visitors. The algorithm and estimation techniques presented here themselves to automation quite easily, in the same manner simple EOQ and stocking level standard routines in many existing enterprise solutions. They can be used directly to stocking policy as well as parameters on an basis, or more realistically, be used to suggest changes to a decision maker.

In case of stockouts, many savvy retailers list items similar to promote substitution, and also provide the date to allow the customer to substitute and waiting by customers allows them to attract a larger market (or at a lower cost) than if they had a fixed assortment of stocked items. Hence growing trends tend to allow customers to make their own substitution/wait/leave decisions. Whatever be the (arguable) benefits of this policy in

the “bricks” world of retailing, there are many benefits for the “clicks” world of on-line retailing. Customers are conditioned to a shipping delay, and may be willing to wait for a short time in order to get first choice. The on-line world provides a wealth of information about customer preferences, stockout and substitution behavior. In addition, to ensure that when stocks arrive, all baskets are empty. To these organizations an understanding of customer waiting behavior is essential to implement profitable intermittent ordering - clearly a strong argument for systematic analysis of stockout behavior (as well as substitution behavior) in the on-line retailing industry.

### 6.1 Enterprise Resource Planning Software

Existing ERP software today has pre-programmed routines that allow calculation of inventory parameters, safety stock (using previous order data), reorder points, and order quantities. We have also provided algorithms that are implementable as additional routines to find out the optimal stocking policy for items of interest, as well as an algorithm to calculate maximum estimator (in linear running time). This allows firms to directly implement the policies that we describe here.

Just as most stocking level calculation used to be done directly change values but to suggest changes to a decision maker, we envisage that the algorithms presented here can be used to suggest changes in policy to the decision maker. This allows for a degree of flexibility that is currently not available in most ERP systems.

### 6.2 Other Considerations

The periodic availability policies that we described have some other implications as well. Since we decrease the average inventory holding time (as compared to a pure EOQ policy), this has a significant impact on accounting measures, like Return on Equity. For online firms this may be an important consideration. Incentives and even existence of common accounting measures of profitability. Since each order is larger than the pure EOQ policy there may be quantity discounts or shipping charges that kick in if a periodic availability policy is adopted. While this is not explicitly modeled in this paper, it is plausible that quantity discounts or shipping charges such a policy even more attractive. While we have looked at the inventory policy that can capitalize on the increased visibility of customer behavior, it is equally important to have business processes that can integrate well with a regular filling of backorders. Online business models have to be

supported by all functional areas in tandem. It is certainly not enough to merely apply a periodic availability policy at the warehouse.

## 7. Conclusion

Our model is just a start however. In the future, sophisticated on-line retailers will use their customer data to model customer behavior in the face of stockouts, changes, available substitutes in the retailer's portfolio, and possibly competitive actions. Hence there will be an increasing need for models that integrate the traditional emphasis on replenishment decisions with other aspects of the system.

In this paper we start from a different perspective on the cost of backorders. We have extended the EOQ model in an intuitive manner which shows the specific conditions under which the EOQ model is optimal, and conditions under which EOQ is not optimal (or profitable) but periodic availability is optimal. This represents a simple but powerful extension of this classic inventory model. Potential extensions to this research include

considering many items to be stocked at one location, the issue of substitution between multiple items, and the ease of competition between retailers using different stocking policies. Each of these occurs in practice, and is relevant to both research and industry.

There are important applications to the field of online inventory, and there are many inventory systems, all including supply chains. In a situation where a stockout causes a partial non-linear loss we assert that it is important to assess the profitability of periodic availability.

## References

[1] Alsop, Stewart. “I’m Betting on Amazon.com,” *Magazine*, April 30, 2001, 48.  
 [2] Anupindi, Ravi; Dada, Maqbool & Gupta, Sachin. “Estimation of Consumer Demand with Stock-Out Substitution: An Application to Vending Machine Marketing,” *Science*, 1998, 17, 406-423.  
 [3] Bassok, Yehuda; Anupindi, Ravi & Akella, Ram. “Single-Period Multiproduct Inventory Models with Substitution,” *Operations Research*, 1999, 47, 632-642.  
 [4] Cetinkaya, S. & Parlur, M. “Optimal Myopic Policy for stochastic inventory problem with fixed and proportional backorder costs,” *EJOR*, 1998, 110, 20-45.  
 [5] Chen, Fangruo & Zheng, Yu-Sheng. “Inventory models with general backorder costs,” *EJOR*, 1993, 65, 175-186.  
 [6] Colvin, Geoffrey. “Shaking Hands On The Web,” *Magazine*, May 14, 2001, 54.  
 [7] Dinkelbach, W. “On Non-Linear Fractional Programming,” *Science*, 1967, 13, 492-498.  
 [8] Ernst, Ricardo & Kouvelis, Panagiotis. “The Effects of Packaging Goods on Inventory Decisions,” *Management Science*, 1999, 45, 1142-1155.  
 [9] Hadley, G. & Whitin, T. M. *Analysis of Inventory Systems*,

- Prentice Hall,  
 [90] Hardy, Quentin. "The Killer Ad machine," *Advertising Age*, December 11, 2000, 168.
- [11] Harris, F. "How many parts to make at once," *Harvard Business Review* 1915, 10, 135-136, 152.
- [12] Lee, Kang Woo. "A Stochastic Partial Backorder System with a Exponential Backorder Ratio," *Journal of the Korean OR-MS Society*, 1996, 21, 71-80.
- [13] Luo, Wenhong. "An integrated Inventory System for Perishable Goods with backordering," *Computers and Industrial Engineering*, 1998, 34, 685-693.
- [14] Manchanda, Puneet; Ansari, Asim & Gupta, Sunil. "Shopping Basket: A Model for Multicategory Purchase Incidence Decisions," *Marketing Science*, 1999, 18, 95-118.
- [15] Montgomery, Douglas C.; Bazaraa M. S. & Keswani, Ajit K. "Inventory Models with a Mixture of Backorders and Lost Sales," *Naval Research Logistics Quarterly*, 1973, 20, 256-268.
- [16] Park, Kyung S. "Another Inventory Model with a Mixture of Backorders and Lost Sales," *Naval Research Logistics Quarterly*, 1983, 30, 397-400.
- [17] Powell, Stephen G. & Ernst, Ricardo. "Optimal inventory policies under service-sensitive demand," *EJOR*, 1995, 327-328.
- [18] Rabinowitz, Gad; Mehrez, Abraham; Chu, Ching-Wu & Patuwo, B. Eddy. "A partial backorder control for non-inventoried (r, Q) inventory system with Poisson demand and constant lead time," *Computers & Operations Research*, 1995, 22, 689-700.
- [19] Robertson, Tim; Wright, F. T. & Dykstra, R. *Restricted statistical inference*, John Wiley & Sons, 1988.
- [20] Rosenberg, David. "A New Analysis of a Lot-Size Model with Partial Backlogging," *Naval Research Logistics Quarterly*, 1979, 26, 349-353.
- [21] Smith, S.A. & Agrawal, N. "Management of retail inventory systems with demand substitution," *Operations Research*, 2000, 48, 50-62.
- [22] Whittin, T. M. "Recent Articles on Partial Backorders," *Naval Research Logistics Quarterly*, 1985, 32, 362-362.
- [23] Zipkin, Paul H. *Foundations of Inventory Management*, McGraw Hill, 2000.

# Common Replenishment Strategies in Supply Chain under Uncertainty Demand Environment

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## Abstract

This paper is based on the model proposed by Viswanathan and continue to analyze the benefit of supply chain inventories through the use of common replenishment epochs. We studied a one-vendor, multi-buyer supply chain for a single product under uncertainty demand environment. The vendor specifies common replenishment periods and asks all buyers to replenish only at those time period and the price discount to be offered by the vendor are determined by the solution to a Stackelberg game. A numerical study is conducted to evaluate the benefit of the strategy by simulation.

Keywords: Supply chain management; Inventory policy; Replenishment schedule; Uncertainty demand

## 1. Introduction

Inventory Control is a criterion of evaluating supply chain management. In a supply chain with vertical structure, optimizing inventory may be realized by enable every component department of the whole supply chain comply with the objective of minimizing the total cost as a whole due to the relationship of administration. But this circumstance does not accord with demand of enterprises constructing horizon integration, so this may not be possible in horizon supply chain. First, the vendors and buyers involved in the supply chain may belong to different corporate entities and be more keen on maximizing their own profit rather than that of supply chain as a whole. Therefore, it is necessary to devise mechanisms for increasing the coordination among entities in the supply chain.

With growing focus on supply chain management, firms realized inventories across entire supply chain could be efficiently managed through cooperation. The management of inventories in distribution or deliver process was paid more attention of scholars opposite to production/inventories systems. Distribution of inventories is important problems because as common a wholesaler usually delivers to several retailers, thus how to distribute inventories between wholesaler and retailers or among

retailers are valuable to integrate.

Axaster & Zhang (1999) analyzed the common replenishment spots impact multi-level inventory control, they supposed storehouse took advantage of common installation Stock as their lot quantity replenish policy, the identical retailers adopt the common replenishment policy, in which phenomenon when the inventory position of all of the retailers decrement to a common order point, the retailer whose inventory level is the least would set the order information. This policy results in higher cost and suits to be applied in some special cases. Viswanathan and Rajesh Piplani [4] integrated the common replenishment strategies between a vendor and more buyers, they proposed a Stackelberg game with the objective to minimize the vendor's cost, the vendor give its buyers some price discount to compensate the increasing on the buyers inventory cost, but they studied the case with definite demand which buyers faced. They did not investigate how to make price facing stochastic demand, and how the parameters of demand to impact the policy.

This paper is based on Viswanathan and Rajesh Piplani's work and studied that when the retailers face uncertainty demand from their customers, the performance of the supply chain including one vendor and more buyers. We suppose the demand of every buyers' customers follow normal distribution with their own parameters including expectation means and standard deviations. Not only two parameters but also they have other more parameters including the annual Demand, the leading time and their shortage cast, holding cost and order cost. We also suppose the vendor replenishes its inventory with lot to lot from its vendor. So its leading time is ignored. At first, the vendor must not have inventory cost, so it adapt the common replenish policy to its buyers. But the buyers cannot accept the increasing of their inventory cost, so the vendor must give the buyers some price discount to compensate with their expense. We studied the solution of price policy with common consistent discount and with their respectably discount scale. At last we investigate the total cost of supply chain as a whole is to be reduced by this common

replenishment policy with a simulation.

## 2. Problem Description

The Supply chain includes a kernel supplier and multiple retailers. The replenishment strategy of the supplier is to take place right away if it need and it does not take the leading time into account. The retailers face the demand of customers, and the demand quantity follows normal distribution. The leading time of retailers send their order can be 0 or any positive number.

Due to in this problem, the supplier is regarded as the hardcore, for the purpose of making no cost on supplier, we adopt common replenishment epochs(CRE). The vendor specifies that buyers can only place orders at specific points in time, for example, every Monday, a certain week of every month, etc. The vendor will insist the interval for each buyer  $i$  which is defined as  $t_i^c$ . So  $t_i^c$  should be an integer multiple of the common replenishment period  $T_0$ . Due to reduce the freedom of buyers placing orders to vendor and increase their inventory costs, the vendor need to provide a price discount  $Z_i$  to compensate buyer  $i$  for inventory cost increase. Therefore, this problem concentrate to determine the  $n_i$  in expression (1) and price discount factor  $Z_i$ .

$$t_i^c = n_i T_0 \quad (1)$$

## 3. Analysis of inventory cost for CRE

### 3.1 Analysis of inventory cost for no use of CRE

#### 3.1.1 Inventory cost construction for buyers

We suppose under the random condition, the optimal replenishment interval corresponding to EOQ for buyer  $i$ . Buyer  $i$  has a order quantity  $Q_i$ , its demand during leading time follows normal distribution  $N(X_{LT}^i, \sigma_{X,LT}^i)$ . And we have need to consider the safety stock.  $k$  is the safety factor, and the demand quantity in a year is  $D_i$ , shortage cost per unit per year is  $\Pi$ , setup cost for every order is  $C_{Setup}^i$ , holding cost per unit per year is  $h$ .

For buyer  $i$ , before the CRE strategy is implemented, optimal order quantity solved corresponding to the EOQ is given by

$$Q_i = \sqrt{\frac{2D_i(C_{Setup}^i + \Pi \sigma_{X,LT}^i g(k_i))}{h_i}} \quad (2)$$

$$\text{where } g(k_i) = \int_{k_i}^{\infty} (z - k_i) f(z) dz$$

and  $f(z)$  is the density function for normal distribution  $N(X_{LT}^i, \sigma_{X,LT}^i)$ . The optimal replenishment interval for Buyer  $i$  is given by

$$t_i^u = \frac{Q_i}{D_i} \quad i = 1 \dots m \quad (3)$$

Its total inventory cost is expressed by

$$\begin{aligned} \therefore TC_i(Q, k_i) &= C_{Setup}^i \frac{D_i}{Q} + \Pi \frac{D_i}{Q} E(g(k_i)) + h_i \left( \frac{Q}{2} + k_i \sigma_{X,LT}^i \right) \\ &= C_{Setup}^i \frac{D_i}{Q} + \Pi \frac{D_i}{Q} \sigma_{X,LT}^i g(k_i) + h_i \left( \frac{Q}{2} + k_i \sigma_{X,LT}^i \right) \end{aligned} \quad (4)$$

#### 3.1.2 Cost analysis for vendor

The vendor purchases the product from external supplier and follows a lot for lot policy, so the vendor does not keep any inventory and orders the required quantity whenever it receives an order from a buyer. Before CRE strategy implemented, the vendor processes each individual buyer's order separately and it only incurs cost for orders. The expression (5) is defined the total cost for the vendor in a year.

$$TC_v^U = \sum_{i=1}^m (C_{Setup}^E + C_v^i) / t_i^u \quad (5)$$

where  $C_{Setup}^E$  is the setup cost incurred by the vendor for processing the entire set of orders/deliveries.

$C_v^i$  is the setup cost incurred by the vendor for processing a specific order from buyer  $i$   
 $m$  is the number of buyers.

### 3.2 Analysis of inventory cost for implementation of CRE

Due to the CRE strategy is a problem modeled as a Stackelberg game, with the vendor acting as the leader and buyers as followers. Its solution is determined to meet the objective to minimize the vendor's cost at first, and then look for the balance spot buyers can receive.

#### 3.2.1 Inventory cost construction for buyers

Referring to the expression (4), we can obtain the total cost for buyer  $i$  is

$$TC_i^a = C_{Setup}^i / t_i^c + h_i * (Q/2 + k_i \sigma_{X,LT}^i) + \Pi \frac{D_i}{Q} \sigma_{X,LT}^i g(k_i)$$

Under the CRE strategy, the replenishment interval for buyer  $i$

is

$$t_i^c = n_i T_0 = Q_i / D \quad (6)$$

thus

$$\therefore Q_i = D_i n_i T_0 \quad (7)$$

Let

$$H_i = (h_i D_i) / 2$$

So

$$TC_i^c = C_{Setup}^i / (n_i T_0) + H_i T_0 + \frac{D_i Q_i}{n_i T_0} + \frac{\sum_{i=1}^m \sigma_i E_S(k_i)}{n_i T_0} \quad (8)$$

### 3.2.2 Cost analysis for vendor

We consider two cases: identical and non-identical discounts for buyers.

In the first case,  $Z$  is the identical discount rate. The cost of vendor is

$$TC_v^c = C_{Setup}^E / n_0 + \sum_{i=1}^m (D_i Z + C_v^i / (n_i T_0)) \quad (9)$$

In the second case,  $Z_i$  is the discount rate for buyer  $i$ . Every buyer possess identical  $Z_i$ . The cost of vendor is given by

$$TC_v^c = C_{Setup}^E / T_0 + \sum_{i=1}^m (D_i Z_i + C_v^i / (n_i T_0)) \quad (10)$$

## 4. Feasibility of CRE

At first, we consider expression (8), its derivative on  $n_i$  is

$$\frac{dTC_i^c}{dn_i} = -\frac{C_{Setup}^i}{T_0 n_i^2} + H_i T_0 - \frac{\sum_{i=1}^m \sigma_i E_S(k_i)}{T_0 n_i^2}$$

and its two order derivative is

$$\frac{d^2 TC_i^c}{dn_i^2} = \frac{2(C_{Setup}^i + \sum_{i=1}^m \sigma_i E_S(k_i))}{T_0 n_i^3}$$

$$Q \quad n_i > 0$$

$$\therefore \frac{d^2 TC_i^c}{dn_i^2} > 0$$

So for every buyer, its cost function is down convex monotonously. Thus for any  $T_0$ , we can find an acceptable  $n_i$  to minimize the total cost.

Set  $n_i^*$  as the multiple enable to minimize the total cost. Thus

$$TC_i^c(n_i^*) \leq TC_i^c(n_i^* + 1) \quad (11)$$

and

$$TC_i^c(n_i^*) \leq TC_i^c(n_i^* - 1) \quad (12)$$

From expression (11) and (12), we can deduce:

$$n_i^*(n_i^* - 1) \leq \frac{C_{Setup}^i + \sum_{i=1}^m \sigma_i E_S(k_i)}{H_i T_0^2} \leq n_i^*(n_i^* + 1) \quad (13)$$

Due to the limitation of order interval by vendor, it must bring increase of total cost of buyers. Only the price discount can counteract and is received by buyers. This is

$$Z \geq \frac{C_{Setup}^i}{D_i} \left( \frac{1}{n_i T_0} - \frac{1}{t_i^u} \right) + \frac{\sum_{i=1}^m \sigma_i E_S(k_i)}{D_i} \left( \frac{1}{n_i T_0} - \frac{1}{t_i^u} \right) + \frac{h_i}{2} (n_i T_0 - t_i^u) \quad (14)$$

Expression (14) is the constraint of CRE strategy. And the objective function is to minimize the vendor's total cost:

$$\text{Min}(TC_v^c) = \text{Min}(C_{Setup}^E / T_0 + \sum_{i=1}^m (D_i Z + C_v^i / (n_i T_0))) \quad (15)$$

If we can solve the common factor of the replenishment cycle of every buyer  $T_0$ , then the problem can be solved.

The problem of determine the  $T_0$  and  $Z$  for the vendor can be formulated as follows (P):

$$\text{Min}(TC_v^c) = \text{Min}(C_{Setup}^E / T_0 + \sum_{i=1}^m (D_i Z + C_v^i / (n_i T_0))) \quad (15)$$

subject to

$$Z \geq \frac{C_{Setup}^i}{D_i} \left( \frac{1}{n_i T_0} - \frac{1}{t_i^u} \right) + \frac{\sum_{i=1}^m \sigma_i E_S(k_i)}{D_i} \left( \frac{1}{n_i T_0} - \frac{1}{t_i^u} \right) + \frac{h_i}{2} (n_i T_0 - t_i^u) \quad (14)$$

$$i = 1, \dots, m,$$

$$T_0 \in X,$$

$$n_i \geq 1 \text{ and integer, } i = 1, \dots, m,$$

$$\text{where } X = \{1/365, 1/52, 1/12, 1/4\}$$

## 5. Solution of CRE

### 5.1 In identical discount strategy

Because  $T_0$  is a discrete time unit and  $n_i$  is a positive integer,  $T_0$  can not be solved by general solution of continuous function. So we refer to solution Viswanathan gave to similar problem, and obtain the search steps as follow:

Step 1. For each  $T_0 = x_j$ ,  $x_j \in X$ , solve  $n_i$  from expression(13).

Step 2. For each buyer  $i$ , determine  $Z_i$  from (14). Set  $Z = \text{Max}\{Z_1, \dots, Z_m\}$

Step 3 Substituting for  $Z$  and  $T_0$  to (15), determine the objective function value. Among all the  $x \in X$ , choose the value that minimizes the objective function value given by (15).

### 5.2 In non- identical discount strategy

When the vendor give every buyer to its respective discount rate to recuperate its respective losing of total cost. That is non-identical discount

strategy. In the course of solution, change the step 2 above paragraphs, substituting for  $Z_i$  to (15) is well.

## 6. Numerical study

In this section, first a numerical example with 5 buyers that demonstrate the benefits of CRE strategy is presented. Not losing generalization, we suppose buyers give their customers the service level of 95%. Their parameters are given in Table 1.

Table 1 Parameters in the experiment

No	$C_{Setup}$	H	$\Pi$	LT	$X_{LT}$	$\sigma_{X,LT}$	D	$S_{buyers}$	
1	1	16	5	20	100		30	1800	10
2	2	15	8	10	56		10	2000	20
3	3	18	20	20	88		20	1600	30
4	5	19	25	7	28		6	1400	40
5	4	20	5	6	100		17	2100	50

In the experiment, we suppose that the setup cost of each order for vendor ( $S_v$ ) is changed from 0 to 70 with 10 of span, and the setup cost for buyer ( $S_b$ ) is changed from 10 to 50 with 10 of span. No losing generalization, we consider all buyers have the same setup cost.

### 6.1 Simulation result for identical discount strategy

The result is given by Table 2. From table 2, we can see that the common replenishment interval increase with  $S_v$ , which demonstrate order cost increasing bring order interval prolonged. Even if  $S_v$  is constant, interval increases monotonously with  $S_b$ . As far the five buyers, they all increase their total cost after CRE is implemented, and that each buyer, CRE bring its total cost increased obviously.

Identical discount rates change with  $S_b$  and  $S_v$ , which is displayed in Figure 1.  $Z$  increases with  $S_v$  and  $S_b$ . That illustrates that from the point of view of vendor, increasing of order cost enhances buyers' total costs, so the discount rate is enhanced respectively.

The direct objective of CRE is to minimize the vendor's cost, from the experiment, vendor's cost is decreased obviously. The more  $S_b$  is, the more vendor's cost is reduced, furthermore, with

$S_v$  rising, vendor's costs on different  $S_b$  show convergent tendency.

For the cost of all supply chain, Figure 3 shows its variation tendency. When  $S_b > 30$ , cost of supply chain descends. The less  $S_b$  is, the easier cutting cost of the system down is. With  $S_v$  increasing, system cost decline, when  $S_b$  changes bigger, the rate for decreasing of system cost is bigger.

### 6.2 Simulation result for non-identical discount strategy

The result of non-identical discount strategy is showed in table 3. Comparing Table 2 and Table 3, non-identical discount strategy reduces more vendor's cost than identical one, because identical one regards the max value of all discount rate for every buyers as the identical rate. Thus some buyer enjoy more preferential price and vendor pays out more cost. Non-identical strategy enables each buyer to enjoy the critical discount rate from vendor according to its cost increased.

Figure 4 shows the variety of vendor's cost on non-identical strategy. And Figure 5 displays the variety of total cost of the supply chain. Relative to Figure 3, we can see that non-identical strategy bring more abatement of total cost of system than identical one, and in different term of  $S_v$ , rate of cost presents convexity more obviously with  $S_b$  than identical one.

## 7. Summary and conclusions

In this paper, a strategy of inventory policy in a one vendor, multi buyer supply chain under uncertainty demand is modeled. The buyers face uncertainty demand from their customers, and the vendor requires all buyers to place their orders at common replenishment epochs. We discuss the solution of order interval and discount rate in this problem on identical and non-identical cases. An extensive numerical study was conducted to show the influence of parameters on CRE strategy. The experiment revealed that CRE strategy can reduce vendor's cost and total cost of the supply chain. And on non-identical discount rate can bring more cost saving on the system cost and vendor's than identical strategy.

Table 2 Detailed result of numerical study for identical											
$S_v$	$S_b$	$T_0$	Ratio of buyer's cost (CRE/No-CRE)					Ratio of vendor's cost (CRE/No-CRE)		Ratio of system's cost (CRE/No-CRE)	
			Buyer 1	Buyer 2	Buyer 3	Buyer 4	Buyer 5	Buyer 6	discount rate		
0	10	5	1.04	1.11	1.04	1.01	1.07	0.79	0.04	0.97	
0	20	14	1.13	1.28	1.03	1.08	1.21	0.7	0.12	0.92	
0	30	16	1.19	1.38	1.06	1.13	1.28	0.62	0.17	0.86	
0	40	18	1.24	1.48	1.09	1.19	1.36	0.57	0.22	0.8	
0	50	20	1.29	1.59	1.13	1.26	1.45	0.53	0.27	0.76	
10	10	11	1.06	1.15	1	1.02	1.1	0.48	0.06	1.03	
10	20	14	1.13	1.28	1.03	1.08	1.21	0.5	0.12	0.95	
10	30	17	1.21	1.43	1.08	1.16	1.32	0.49	0.19	0.89	
10	40	19	1.27	1.53	1.11	1.23	1.4	0.47	0.24	0.83	
10	50	21	1.32	1.64	1.16	1.3	1.49	0.45	0.29	0.78	
20	10	12	1.09	1.19	1.01	1.03	1.13	0.36	0.08	1.08	
20	20	15	1.16	1.33	1.04	1.1	1.24	0.4	0.15	0.99	
20	30	17	1.21	1.43	1.08	1.16	1.32	0.41	0.19	0.9	
20	40	19	1.27	1.53	1.11	1.23	1.4	0.4	0.24	0.84	
20	50	21	1.32	1.64	1.16	1.3	1.49	0.4	0.29	0.79	
30	10	13	1.11	1.24	1.02	1.05	1.17	0.3	0.1	1.14	
30	20	15	1.16	1.33	1.04	1.1	1.24	0.34	0.15	1.01	
30	30	18	1.24	1.48	1.09	1.19	1.36	0.35	0.22	0.93	
30	40	20	1.29	1.59	1.13	1.26	1.45	0.36	0.27	0.86	
30	50	21	1.32	1.64	1.16	1.3	1.49	0.35	0.29	0.8	
40	10	13	1.11	1.24	1.02	1.05	1.17	0.26	0.1	1.17	
40	20	16	1.19	1.38	1.06	1.13	1.28	0.3	0.17	1.05	
40	30	18	1.24	1.48	1.09	1.19	1.36	0.31	0.22	0.95	
40	40	20	1.29	1.59	1.13	1.26	1.45	0.32	0.27	0.87	
40	50	22	1.35	1.69	1.18	1.33	1.53	0.32	0.32	0.82	
50	10	14	1.13	1.28	1.03	1.08	1.21	0.23	0.12	1.22	
50	20	16	1.19	1.38	1.06	1.13	1.28	0.27	0.17	1.07	
50	30	18	1.24	1.48	1.09	1.19	1.36	0.28	0.22	0.96	
50	40	20	1.29	1.59	1.13	1.26	1.45	0.29	0.27	0.89	
50	50	22	1.35	1.69	1.18	1.33	1.53	0.3	0.32	0.83	
60	10	14	1.13	1.28	1.03	1.08	1.21	0.22	0.12	1.26	
60	20	17	1.21	1.43	1.08	1.16	1.32	0.24	0.19	1.1	
60	30	19	1.27	1.53	1.11	1.23	1.4	0.26	0.24	0.99	
60	40	21	1.32	1.64	1.16	1.3	1.49	0.27	0.29	0.91	
60	50	22	1.35	1.69	1.18	1.33	1.53	0.28	0.32	0.84	
70	10	15	1.16	1.33	1.04	1.1	1.24	0.2	0.15	1.31	
70	20	17	1.21	1.43	1.08	1.16	1.32	0.23	0.19	1.12	
70	30	19	1.27	1.53	1.11	1.23	1.4	0.24	0.24	1	
70	40	21	1.32	1.64	1.16	1.3	1.49	0.25	0.29	0.92	

70 50 23 1.38 1.75 1.2 1.37 1.57 0.26 0.34 0.85

**Table 3** Detailed result of numerical study for non-identical

$S_v$	$S_b$	$T_0$ strategy	Ratio of buyer's cost (CRE/No-CRE)				Ratio of vendor's cost (CRE/No-CRE)		Ratio of system's cost (CRE/No-CRE)	
			Buyer 1	Buyer 2	Buyer 3	Buyer 4	Buyer 5	Buyer 6	Buyer 7	Buyer 8
0	10	12 <sup>5</sup>	1.09	1.19	1.01	1.03	1.13	0.75	0.98	
0	20	15	1.16	1.33	1.04	1.1	1.24	0.63	0.9	
0	30	18	1.24	1.48	1.09	1.19	1.36	0.56	0.85	
0	40	20	1.29	1.59	1.13	1.26	1.45	0.51	0.79	
0	50	22	1.35	1.69	1.18	1.33	1.53	0.48	0.75	
10	10	13	1.11	1.24	1.02	1.05	1.17	0.43	1.03	
10	20	16	1.19	1.38	1.06	1.13	1.28	0.45	0.94	
10	30	18	1.24	1.48	1.09	1.19	1.36	0.44	0.86	
10	40	20	1.29	1.59	1.13	1.26	1.45	0.43	0.8	
10	50	22	1.35	1.69	1.18	1.33	1.53	0.41	0.76	
20	10	13	1.11	1.24	1.02	1.05	1.17	0.32	1.06	
20	20	16	1.19	1.38	1.06	1.13	1.28	0.36	0.96	
20	30	19	1.27	1.53	1.11	1.23	1.4	0.37	0.89	
20	40	21	1.32	1.64	1.16	1.3	1.49	0.37	0.83	
20	50	23	1.38	1.75	1.2	1.37	1.57	0.36	0.77	
30	10	14	1.13	1.28	1.03	1.08	1.21	0.27	1.11	
30	20	17	1.21	1.43	1.08	1.16	1.32	0.31	1	
30	30	19	1.27	1.53	1.11	1.23	1.4	0.32	0.9	
30	40	21	1.32	1.64	1.16	1.3	1.49	0.32	0.84	
30	50	23	1.38	1.75	1.2	1.37	1.57	0.32	0.78	
40	10	15	1.16	1.33	1.04	1.1	1.24	0.23	1.17	
40	20	17	1.21	1.43	1.08	1.16	1.32	0.27	1.02	
40	30	20	1.29	1.59	1.13	1.26	1.45	0.28	0.93	
40	40	22	1.35	1.69	1.18	1.33	1.53	0.29	0.86	
40	50	23	1.38	1.75	1.2	1.37	1.57	0.29	0.79	
50	10	15	1.16	1.33	1.04	1.1	1.24	0.21	1.2	
50	20	18	1.24	1.48	1.09	1.19	1.36	0.24	1.05	
50	30	20	1.29	1.59	1.13	1.26	1.45	0.26	0.95	
50	40	22	1.35	1.69	1.18	1.33	1.53	0.27	0.87	
50	50	24	1.41	1.8	1.22	1.4	1.61	0.27	0.81	
60	10	16	1.19	1.38	1.06	1.13	1.28	0.19	1.25	
60	20	18	1.24	1.48	1.09	1.19	1.36	0.22	1.07	
60	30	20	1.29	1.59	1.13	1.26	1.45	0.24	0.96	
60	40	22	1.35	1.69	1.18	1.33	1.53	0.25	0.88	
60	50	24	1.41	1.8	1.22	1.4	1.61	0.25	0.82	
70	10	16	1.19	1.38	1.06	1.13	1.28	0.18	1.27	
70	20	19	1.27	1.53	1.11	1.23	1.4	0.2	1.11	

70	30	21	1.32	1.64	1.16	1.3	1.49	0.22	0.99
70	40	23	1.38	1.75	1.2	1.37	1.57	0.23	0.9
70	50	25	1.44	1.86	1.25	1.44	1.66	0.23	0.84

## References

- [1] Guder. F. And Iydiak, J. L. "Ordering Policies for Multiple-item inventory system to multiple resource constraints". *Computers & Operation Research*, 1999, 26(6) ; 583—597
- [2] Lan S.P. "A Simple Method to Locate the optimal solution of the inventory model with variable lead time". *Computers & Operation Research*, 1999, 26(6) ; 599—605
- [3] Flynn.J. and Garstka. "The optimal review period in a dynamic inventory model." *Operation Research*. 1997 45(5): 736-750.
- [4] S. Viswanathan and Rajesh Piplani, "Coordinating supply chain inventories through common replenishment epochs", *European Journal of Operational Research*, Volume 129, Issue 2, 1 March 2001, 277-286
- [5] Nicholas A. Nechval, Konstantin N.Nechval, "Applications of invariance to estimation of safety stock levels in inventory model", *Computer & Industrial Engineering* 37(1999) 247-250
- [6] Viswanathan, S., 1996. "A new optimal algorithm for the joint replenishment problem". *Journal of the Operational Research Society* 47, 936-944.
- [7] David Simchi-Levi, Philip Kaminsky, Edith Simchi-Levi. *Designing and Managing the Supply Chain*, The McGraw-Hill Companies, Inc. 2000

Figure 1 Discount rate with  $S_v$  and  $S_b$

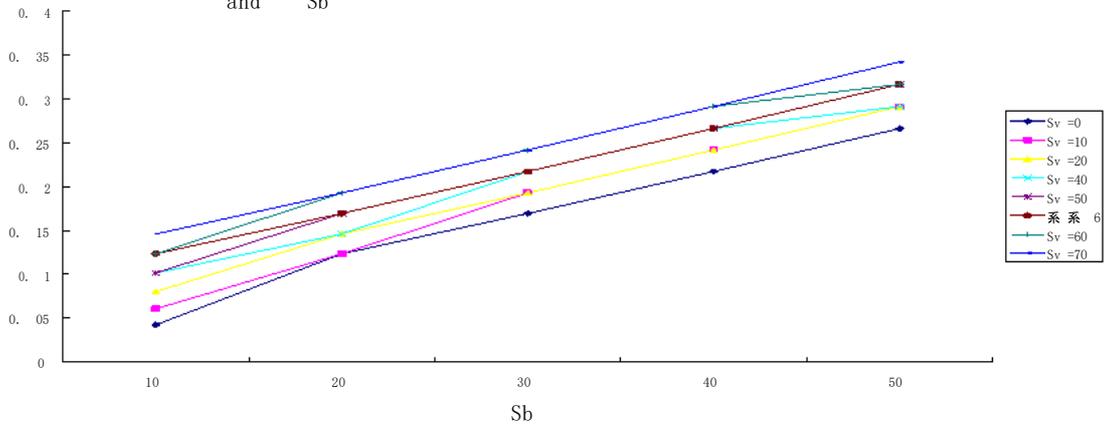


Figure 2 Cost saving of vendor

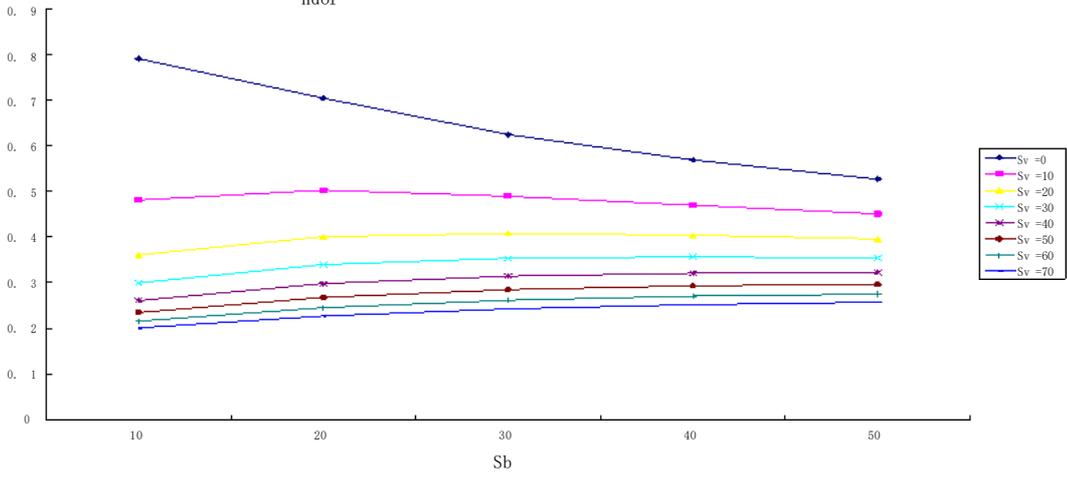
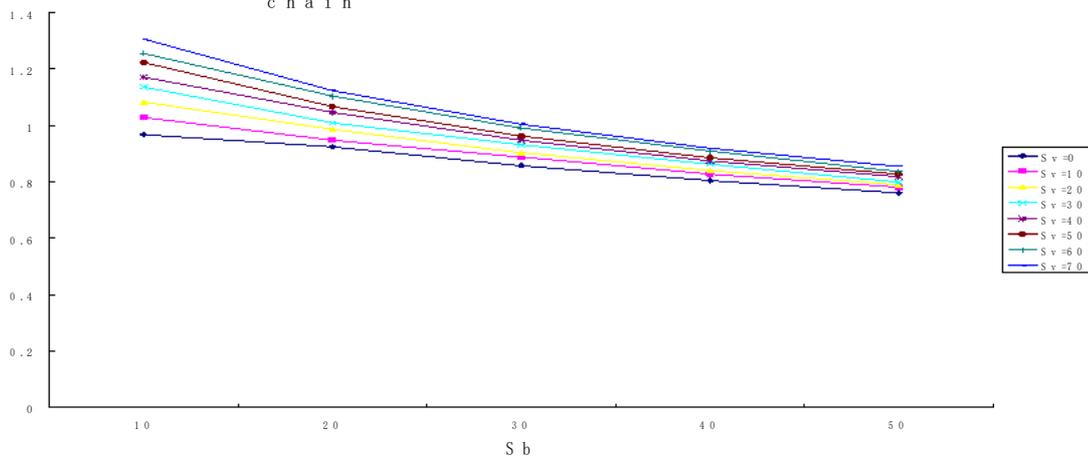


Figure 3 Cost saving of supply chain



Note: Figure 1 to 3 are on identical discount strategy.

Figure 4 Cost saving of vendor

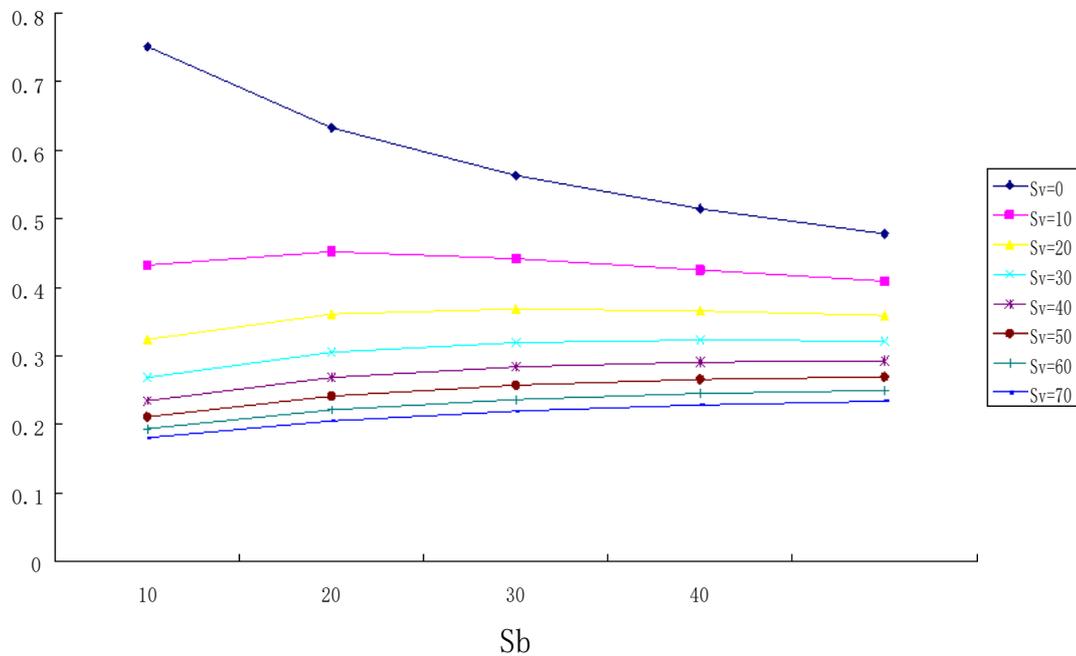
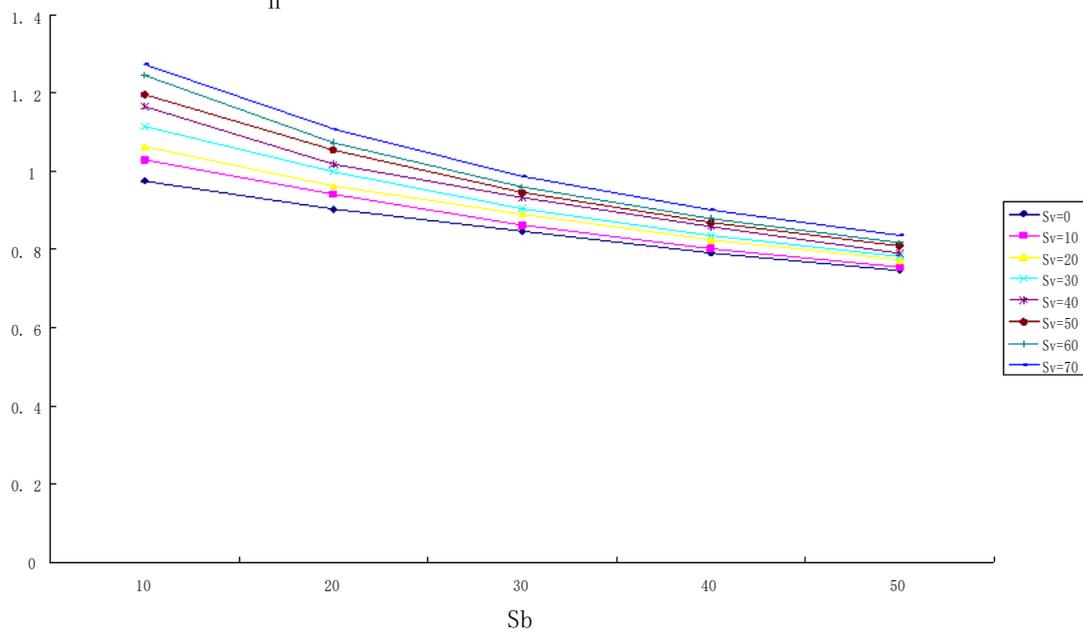


Figure 5 Cost saving of supply chain



Note: Figure 4 to 5 are on non-identical discount strategy.

# E-Mail as a Decision Tool for Asynchronous Group

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## Abstract

E-mail is an indispensable communication tool in the modern enterprise organizations. E-mail is also so prominent for these teams that they communicate via e-mail daily, and is the main media for asynchronous meetings. This study explores the suitability of using e-mail to support group decision making. In order to reduce the communication obstacle which the group may encounter while using the asynchronous communication of E-mail, this study proposes two group techniques suitable for E-mail-Nominal Group Technique (NGT) and Round-Robin NGT. This study also explores the effectiveness of E-mail-mediated group supported by the structured group techniques and which type of task suitable for E-mail-mediated group. An experiment involving a total of 150 undergraduates was conducted. Results show that group techniques used in this study appears to be useful for facilitating E-mail-mediated group. But task type had no significant influence on E-mail-mediated group.

Keywords : E-mail, Nominal Group Technique, Task Type, Group Decision Making

## 1. Introduction

Electronic mail (E-mail) is undoubtedly the most successful application in the cyberspace. Even someone said that the e-mail has been the most successful communication technology since the invention of the TV.

E-mail also plays an important role in organization communication. Two major organizational shifts are the movement toward teams and the movement toward nonstandard work schedules. This has simultaneously increased the need for meetings and decreased the ability to meet [1]. In order to meet the new environment, one of the trends is virtual teams - groups of people who work together although they are often dispersed across space, time, and/or organizational boundaries.

After studied 12 virtual teams, Lurey and Raisinghani [2] found that e-mail was so prominent for these teams that 80% of the team members communicated via e-mail daily. Other team-based communication technologies like group telephone conferences, groupware applications, and video conferences were not often used. E-mail is the main tool to support asynchronous meeting and an important media to support future organization (virtual organization)[3].

On the other hand, most of computer-mediated communication research focused on Group Support Systems (GSS) research. Results of these studies show that using GSS brings considerable productivity promotion and reduces costs for organizations [4]. But the efforts of GSS research had limited effect on business world, GSS is diffusing slowly [5] [6]. Besides, Most of GSS research limited to "decision room" support system for synchronous communication. Mandviwalla and Gray [5] suggested that GSS research should expand to include commercial systems and to asynchronous and distributed work.

This study explores the suitability of using e-mail to support asynchronous group decision making.

## 2. Literature Review

### 2.1. Electronic mail

Massachusetts Institute of Technology designed E-mail in 1965 for experiment purpose. In 1969, US military developed ARPANET to link up computers as a network; E-mail was the most popular and frequently used application [7]. E-mail began to be used commercially in 1977.

The range of early E-mail definition is very extensive, from telex to computer conferencing system. Almost all the electronic ways to convey message can be called E-mail.

This study follows the definitions of Sproull and Kiesler [7]. An Electronic Mail System (EMS) uses computer text-processing and communication tools to provide a high speed information exchange service anyone with a computer account can create and send information to anyone who has a mailbox on that computer or on any other computer to which it is connected through a computer network.

### 2.2. E-mail-mediated Meeting

Sproull and Kiesler [8] organized a series of email meeting reports, they found that computer-mediated meeting was equal than face-to-face meeting, namely the conferee had equal time to provide opinions. E-mail also drew the status disparities of conferee. In the face-to-face meeting, the high social status conferee's opinion had obvious influence to final conclusion; the same situation is not relatively obvious in E-mail-mediated meeting.

On the other hand, conferee in face-to-face meeting

which speak in turn tended to follow and agree with previous speaker. This kind of trend was not so obvious in E-mail-mediated meeting. The result of study showed that E-mail lacked the social context to incline to be unanimous and convergent. When needing a common consensus to make decision, E-mail-mediated meeting required more time and efforts.

Shirani et al, [9] thought that E-mail was asynchronous in both time and place, which allows, and perhaps encourages, greater use of human information processing resulting in deeper analysis which is crucial in the late stages of a group decision.

### 2.3. Nominal Group Technique

Nominal Group Technique (NGT) was developed by Andre L. Delbecq and Andrew H. Van de Ven in 1968. It was derived from social-psychological studies of decision conferences, management-science studies of aggregating group judgments, and social-work studies of problems surrounding citizen participation in problem planning. The NGT overcomes a number of critical problems typical interacting groups, such as, individual inhibitions and premature evaluation in interacting groups result in a decrease in quality of group ideas in terms of creativity, originality, and practicality. And the interacting group tends to pursue a single train of thought for long periods.

Perry [10] found from interview that E-mail is great for discussing and exchanging information, but it is hard to reach a decision about something that is complex and multifaceted.

Same results also found in other literature [8, 11, 12], usually members of distributed or asynchronous group are difficult to keep consciousnesses of being in a group [6, 12]. E-mail lacks for relevant social clues to understand others' real purposes of their expression [8, 9], and when or where to stop discussing [8, 10].

E-mail is used in asynchronous situation mainly, and a kind of comparatively poor social clues communication tool [13]. For preventing the problem mentioned above, it needs special structural group technique to support [3, 14], like Nominal Group Technique (NGT) or Delphi Techniques [15].

The structural group techniques were designed to coordinate communication and solve obstacles and settle difficulties that may be encountered in face-to-face communication. And relevant researches did prove that NGT was able to reach the anticipated goal. Moreover, asynchronous communication is much more often to encounter communication obstacles. Dowling and Louis [1] found that asynchronous group can benefit from NGT than synchronous groups.

The purposes of this study are to explore the effectiveness of NGT supported E-mail-mediated group. But because the original design of NGT is in a meeting room, mediated by paper and pen, and face-to-face. The implementation of NGT with e-mail in this study would slightly change. This study took the original spirit of NGT, and referred to relevant researches [1, 15, 16], and proposed two group techniques suitable for E-mail. The one close to the original design is named "Nominal

Group Technique (NGT)". The second modification is called "Round-Robin NGT". This study also added E-mail-mediated meetings without group technique support called "Interacting Groups".

### 2.4. Task Type

McGrath [17] has combined the main ideas of a number of scientists into a conceptually related set of distinctions about tasks. McGrath proposes that there are four general processes. They indicate what the group is to do: to Generate (alternatives), to Choose (alternatives), to Negotiate, and to Execute.

Choose type tasks can be subdivided into Intellectual type and Decision-Making type (Preference type). There is a logically correct answer in Intellectual task, the goal of the task is to find out this correct answer; No obvious correct answer in Preference task, the goal of the task is to seek the common consensus while everyone having a different preference.

In the theory of information richness, Daft and Lengel [18] argued that there is an optimal fit between situational equivocality and media. And the main notion of task-media fitness theory [17] is that optimal richness requirement of tasks varies from type to type and the performance of a group depends on the extent to which the task fits the communication environment [19]. That is to say that complicated tasks relying on members' interaction to coordinate conflict and convey social clues. Complicated tasks relatively need media that can convey rich information.

## 3. Research Hypotheses

The purposes of this study are to compare E-mail-mediated meetings supported with or without group technique (Interacting group, NGT and Round-Robin NGT) and to explore which type of task suitable for E-mail-mediated group. This study focuses on group decision outcome and team relationship development. According to these goals, we developed the following hypotheses.

The purposes of NGT are to offer conferee time to deliberate, chance to participate, and a situation to concentrate on topic. NGT is superior to Interacting group no matter at productivity or satisfaction [20]. The disparity on satisfaction is especially obvious. The meetings of E-mail usually to go on by asynchronous way and members are relatively difficult to keep consciousnesses of being in a group, and to understand others' real purposes of their expression for e-mail lacking relevant social clues. Moreover, Dowling and Louis [1] found that groups using asynchronous NGT produce better decision results within shorter time than using face-to-face NGT.

NGT offer members fair chances to participate in discusses [20]. When members can participate in the meeting, and make some contribution to last decision, they will probably be satisfied with the decision, too [21]. So we proposed H1a, H1b, H2a and H2b as follow

H1a: Under conditions of Preference task, E-mail-mediated groups supported by group technique (NGT or Round-Robin NGT) will be more satisfied with the decision than those not supported by group technique (Interacting group)

H1b: Under conditions of Preference task, E-mail-mediated groups supported by group technique (NGT or Round-Robin NGT) will be more satisfied with the decision scheme than those not supported by group technique (Interacting group)

H2a: Under conditions of Intellectualive task, E-mail-mediated groups supported by group technique (NGT or Round-Robin NGT) will be more satisfied with the decision than those not supported by group technique (Interacting group)

H2b: Under conditions of Intellectualive task, E-mail-mediated groups supported by group technique (NGT or Round-Robin NGT) will be more satisfied with the decision scheme than those not supported by group technique (Interacting group)

Group members' more effective information exchange may cause them to understand their task s better and generate more creative solutions, thereby leading to better decisions [22]. The main purpose of group techniques is to dispel the communication obstacles. Besides, in Round-Robin NGT the conferee can see others' suggestion at the same time while expressing an opinion; it is to increase conferee to keep senses of participation and cohesion [23]. Members of cohesive teams tend to engage in more social interactions and view mutual opinions positively [21]. So we proposed H3a and H3b as follow.

H3a: Under conditions of Preference task, E-mail-mediated groups supported by group technique (NGT or Round-Robin NGT) will make better decision than those not supported by group technique (Interacting group)

H3b: Under conditions of Intellectualive task, E-mail-mediated groups supported by group technique (NGT or Round-Robin NGT) will make better decision than those not supported by group technique (Interacting group)

Preference task has no correct answer; it can only rely on group members to discuss, coordinate conflict, and reached a common view. Intellectualive task has an only one correct answer, members only need to participate in meeting and exchange information with each other. Do not need to coordinate the cognitive conflict of each other very much among members.

For Preference task, E-mail might be unable to offer enough social clues and decline members' satisfaction and perceived decision quality. Intelligence type task will not face this kind of situation. So we proposed the following hypotheses.

H1c: In E-mail-mediated meeting without supported by group technique

(Interacting group), groups facing Intellectualive task will be more satisfied with decision than those facing Preference task

H1d: In E-mail-mediated meeting supported by NGT,

groups facing Intellectualive task will be more satisfied with decision than those facing Preference task

H1e: In E-mail-mediated meeting supported by Round-Robin NGT, groups facing Intellectualive task will be more satisfied with decision than those facing Preference task

H2c: In E-mail-mediated meeting without supported by group technique

(Interacting group), groups facing Intellectualive task will be more satisfied with decision scheme than those facing Preference task

H2d: In E-mail-mediated meeting supported by NGT, groups facing Intellectualive task will be more satisfied with decision scheme than those facing Preference task

H2e: In E-mail-mediated meeting supported by Round-Robin NGT, groups facing Intellectualive task will be more satisfied with decision scheme than those facing Preference task

H3c: In E-mail-mediated meeting without supported by group technique

(Interacting group), groups facing Intellectualive task will make better decision than those facing Preference task

H3d: In E-mail-mediated meeting supported by NGT, groups facing Intellectualive task will make better decision than those facing Preference task

H3e: In E-mail-mediated meeting supported by Round-Robin NGT, groups facing Intellectualive task will make better decision than those facing Preference task

As to asynchronous group, relationship development is much harder than face-to-face group. But for the group supported by group technique, the technique will facilitate communication [20]. Team members should also be more willing and able to communicate freely and help each other [24]. Besides, in Round-Robin NGT the conferee can see others' suggestion at the same time while expressing an opinion; it is to increase conferee to keep senses of participation and cohesion [23]. So we proposed H4a, H4b, H5a and H5b.

H4a: Under conditions of Preference task, E-mail-mediated groups supported by Round-Robin NGT will have higher team cohesiveness than those not supported by Round-Robin NGT

H4b: Under conditions of Intellectualive task, E-mail-mediated groups supported by Round-Robin NGT will have higher team cohesiveness than those not supported by Round-Robin NGT

H5a: Under conditions of Preference task, E-mail-mediated groups supported by Round-Robin NGT will have higher team collaboration than those not supported by Round-Robin NGT

H5b: Under conditions of Intellectualive task, E-mail-mediated groups supported by Round-Robin NGT will have higher team collaboration than those not supported by Round-Robin NGT

## 4. Research Method

The research hypotheses were tested using a factorial

experiment design (2x3) with E-mail-mediated group supported by group technique and task type as independent variables. E-mail-mediated group supported by group technique with three levels: Interacting group (no group technique support), NGT support, and Round-Robin NGT support. And task type with two levels: Preference task and Intellectualive task.

NGT was adopted from the face-to-face design of Delbacq and Van de Ven [20] and modified to suit to e-mail environment. Round-Robin NGT was another version of modification.

Preference task was "Personal Trust Foundation" by Watson [25]. And Intellectualive task was "Murder One" by Pfeiffer and Jones [26]. Both tasks had been thoroughly tested by empirical studies in information systems and small group research.

Each dependent variable was measured by questionnaire. Perceived decision satisfaction and perceived decision scheme satisfaction was measured with six questions from Green and Taber [27]. Eight questions from Green and Taber [27] were used to measure perceived decision quality was measured with. Team cohesion was measured with three questions from Sashore [28]. Team collaboration was assessed with two questions from Larson and LaFasto [24]. All the original anchors and scales had been thoroughly tested by empirical studies in social psychology and information systems.

#### 4.1. Subject

A total of 150 undergraduates voluntarily participated in this study. Their average age was 19.37. The subjects were randomly assigned to teams of five members each. This team size was used because many decision teams in organization have this size. Thirty teams were randomly assigned to six experiment cells (2x3). Each participant uses e-mail software built in Windows operation system to perform a six-day experiment at home or dormitory. They communicated using specially assigned electronic mail address or their own e-mail address (controlled by backup mail transmitted to facilitator) when carry out their tasks.

### 5. Data Analysis

#### 5.1. Validity and Reliability

Data for dependent variables, collected after meeting were subject to validity and reliability analyses. The results of factor analyses for data collected showed that each question loaded highly on its intended dependent variable. All the dependent variables satisfied criteria for reliability at Cronbach's alpha 0.7. Thus, all the dependent variables had construct validity.

#### 5.2. Hypotheses Tests

A MANOVA test involving all independent and dependent variables was carried out first. Results revealed that the interaction effect of two independent variables on all dependent was not significant. With the results, separate ANOVA tests and Tukey's LSD multiple comparisons test (if needed) could be performed for each dependent variable. All dependent variables could meet homogeneity and normality requirements of the ANOVA test. Table I shows the result of tests for all hypotheses.

Under conditions of Intellectualive task, E-mail-mediated group supported by group technique (no matter NGT or Robin-Robin NGT) had higher decision and decision scheme satisfaction than those not supported by group technique (H1b, H2b). Results suggest that proper group technique could reduce the influence of group think and group shifts which leads to higher perceived satisfaction. Under conditions of Preference task, only groups using Robin-Robin NGT had higher perceived satisfaction (H1a, H2a).

As to perceived decision quality, group supported by group technique (no matter NGT or Robin-Robin NGT) had higher perceived decision quality under conditions of Preference task (H3a). Result suggests that with group techniques participants have more equal chance to participate in meeting and concentrate on task topic which leads to better decision quality. Because Intellectualive task has an only correct answer, members only need to exchange enough information with each other to solve the task. The group technique used in this study had no significant effect on decision quality under Intellectualive task (H3b).

The lack of effect on team cohesion (H4a, H4b) suggested that team cohesion depends on the accumulation of feelings and interacting experience. Group techniques in this study had no significant effect on team cohesion.

As to team collaboration, no matter under which type of task, group supported by Round-Robin NGT had better result than those not supported by Round-Robin NGT (H5a, H5b). The merit of Round-Robin NGT for conferee to see others' suggestion at the same time while expressing an opinion has a positive effect on team collaboration. However, group supported by NGT were limited to a central messages source. The team collaboration of groups supported by NGT was the same as Interacting groups. The lack of impact of Task type no on most dependent variables may be explained in two ways. First the volunteers were to learn to meet with e-mail and solve the task at the same time. Thus, the effect of task type was not so significant. Another explanation is that E-mails may be not a poor media for the volunteers in this study. According to Lee [13], the volunteers in this study were quite familiar with the computer, network and E-mail. And thus they were able to filter out necessary and rich information from the lean media – email.

Table I : Results of Tests (\* : p&lt;0.05 \*\* : p&lt;0.01)

Dependent variables	Hypotheses	P value	Notation
decision satisfaction	H1a	0.001**	Round-Robin NGT>Interacting
scheme satisfaction	H2a	0.011*	Round-Robin NGT>Interacting
decision quality	H3a	0.002**	Round-Robin NGT=NGT>Interacting
team cohesion	H4a	0.261	
team collaboration	H5a	0.007**	Round-Robin> NGT NGT=Interacting
decision satisfaction	H1b	0.032*	Round-Robin NGT=NGT>Interacting
scheme satisfaction	H2b	0.000**	Round-Robin NGT=NGT>Interacting
decision quality	H3b	0.124	
team cohesion	H4b	0.198	
team collaboration	H5b	0.016*	Round-Robin NGT> NGT=Interacting
decision satisfaction	H1c	0.916	
scheme satisfaction	H2c	0.046*	
decision quality	H3c	0.835	
decision satisfaction	H1d	0.462	
scheme satisfaction	H2d	0.855	
decision quality	H3d	0.201	
decision satisfaction	H1e	0.196	
scheme satisfaction	H2e	0.290	
decision quality	H3e	0.350	

## 6. Conclusion

The results from the experiment point to four general conclusions.

First, when under Preference task, Round-Robin NGT can provide enough ability to coordinate communication process. Results show that E-mail mediated group has better decision outcome such as decision satisfaction, decision scheme satisfaction, and decision quality and team relationship such as team collaboration.

Second, when under Preference task, though the group techniques used in this study has no significant effect on decision quality, both NGT and Round-Robin NGT can enhance decision satisfaction, decision scheme satisfaction. Moreover, Round-Robin NGT can also promote team collaboration under Intellective task.

Third, task type has no significant effect on most dependent variables. The difference of task type will not affect E-mail-mediated Groups.

Fourth, the lack of effect on team cohesion suggested that team cohesion depends on the accumulation of feelings and interacting experience. Group techniques in this study had no significant effect on team cohesion.

Meta-analyses of prior research results suggest that when teams used electronic communication, they tend to report better perceived decision quality but poorer decision satisfaction [29]. The proposed group techniques can help asynchronous group to raise perceived decision quality and satisfaction simultaneously.

Mandviwalla and Gray [5] analyzed a large amount of GSS research, and suggested that GSS research should expand to include commercial systems, expand beyond face-to-face meetings to asynchronous and distributed work in multimedia environments, emphasize complex

tasks and realistic subjects, and examine systems based on different perspectives. This study expanded traditional GSS research to asynchronous meeting and electronic mail system. This study provides a different thinking direction for relevant research.

In business environment characterized by intense competition, and globalization, asynchronous group supported by e-mail could be an effect way to solve business problems. The group technique proposed in this study can address the communication obstacle of asynchronous e-mail group. Further research must be carried out in this direction.

## References

- [1]. Dowling, K.L. and Louis, R.D.S., "Asynchronous implementation of the nominal group technique: is it effective?," *Decision Support Systems*, 2000, 29.
- [2]. Lurey, J.S. and Raisinghani, M.S., "An empirical study of best practices in virtual teams," *Information & Management*, 2000, 38, 523-544.
- [3]. Huang, W., Watson, R.T., and Wei, K.K., "Can a lean e-mail medium be used for rich communication? A psychological perspective," *European Journal of Information Systems*, 1998, 7(4), 269-274.
- [4]. Nunamaker, J.F.J., et al., "Lessons from a dozen years of group support systems research: a discussion of lab and field findings," *Journal of Management Information Systems*, 1996-97, 13(3), 163-207.
- [5]. Mandviwalla, M. and Gray, P., "Is IS research on GSS relevant?," *Information Resources Management Journal*, 1998, 11(1), 29-37.
- [6]. Briggs, R.O., Nunamaker, J.F.J., and Sprague, R.H.J., "1001 unanswered research questions in GSS," *Journal of Management Information Systems*, 1997-1998, 14(3), 3-21.
- [7]. Sproull, L. and Kiesler, S., "Reducing social context cues: electronic mail in organizational communication,"

Management Science, 1986, 32(11), 1492-1512.

[8]. Sproull, L. and Kiesler, S., *Connections: New ways of working in the networked organization*, USA: MIT Press, 1991.

[9]. Shirani, A.I., Tafti, M.H.A., and Affisco, J.F., "Task and technology fit: a comparison of two technologies for synchronous and asynchronous group communication," *Information & Management*, 1999, 36, 139-150.

[10]. Perry, T.S., "E-mail at work," *IEEE Spectrum*, 1992, 29(10), 24-28.

[11]. Tan, B.C.Y., et al., "A dialogue technique to enhance electronic communication in virtual teams," *IEEE Transactions on Professional Communication*, 2000, 43(2), 153-165.

[12]. Romano, N.C., Jr., Nunamaker, J.F.J., and Briggs, R.O. "User driven design of web-base group support systems". in the 30th Annual Hawaii International Conference on System Sciences. 1997.

[13]. Lee, A.S., "Electronic mail as a medium for rich communication: an empirical investigation using hermeneutic interpretation," *MIS Quarterly*, 1994, 18(2), 143-157.

[14]. Downing, K.L. and Louis, R.D.S., "Asynchronous implementation of the nominal group technique: is it effective?," *Decision Support Systems*, 2000, 29.

[15]. Delbecq, A.L., Van de Ven, A.H., and Gustafson, D.H., *Group Techniques for Program Planning, a Guide to Nominal Group Technique and Delphi Processes.*, USA: Scott Foreman, 1975.

[16]. Paulus, P.B. and Yang, H.C., "Idea generation in groups: a basis for creativity in organizations," *Organizational behavior and human decision processes*, 2000, 82(1), 76-87.

[17]. McGrath, J.E., *Groups: Interaction and Performance*, Englewood Cliffs, New Jersey: Prentice-Hall, 1984.

[18]. Daft, R.L. and Lengel, R.H., "Organizational information requirement, media richness and structural design," *Management Science*, 1986, 32(5), 554-571.

[19]. McGrath, J.E. and Hollingshead, A.B., *Groups Interacting with Technology: Ideas, Evidence, Issues, and an Agenda.*, USA: Sage Publications, Inc., 1994.

[20]. Van de Ven, A.H. and Delbecq, A.L., "The effectiveness of nominal, Delphi and interacting group decision making process," *Academy of Management Journal*, 1974, 17(4), 605-621.

[21]. Shaw, M.E., *Group Dynamics: The Psychology of Small Group Behavior*. 3rd ed, New York: McGraw-Hill, 1981.

[22]. Gouran, D.S., Brown, C., and Henry, D.R., "Behavioral correlates of perceptions of quality in decision-making discussions," *Communication Monographs*, 1978, 45(3), 51-63.

[23]. Aiken, M., Vanjani, M., and Joseph, P., "A comparison of two electronic idea generation techniques," *Information & Management*, 1996, 30, 91-99.

[24]. Larson, C.E. and LaFasto, F.M.J., *Teamwork: what must go right/what can go wrong*, Newbury Park, CA: Sage, 1989.

[25]. Watson, R.T., DeSanctis, G., and Poole, S., "Using a GDSS to facilitate group consensus: some intended and unintended consequences," *MIS Quarterly*, 1988, 12(3), 463-478.

[26]. Pfeiffer, J.W. and Jones, J.E., *Handbook of structured experience for human relations: training* ., Vol. VI: University Associates, 1985.

[27]. Green, S.G. and Taber, T.D., "The effects of three social decision schemes on decision group process," *Organizational Behavior and Human Performance*, 1980, 25, 97-106.

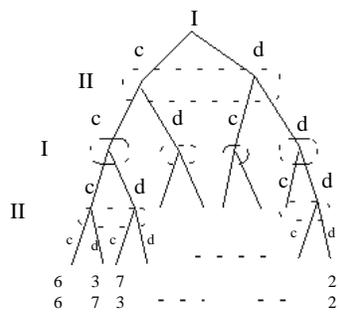
[28]. Sashore, S.E., *Group cohesiveness in the industrial work group*, Ann Arbor, MI: Univ. Mich. Press, 1954.

[29]. Dennis, A.R., Haley, B.J., and Vandenberg, R.J. "A

meta-analysis of effectiveness, efficiency, and participant satisfaction in group support systems research," in *International Conference on Information Systems*. 1996.

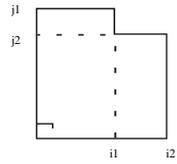


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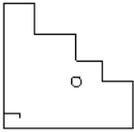




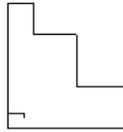
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$G(n,n)$  after 1 move



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I selects  $\circ$



$G(n,n)$  after  $k+1$  moves

# Determining Successful Negotiation Strategies: The Evolution of Intelligent Agents

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## Abstract

Due to the desire of almost all departments of business organizations to be interconnected and to make data accessible at any time and any place, more and more multi-agent systems are applied to business management. As numerous agents are roaming through the Internet, they compete for the limited resource to achieve their goal. In the end, some of them will succeed, while the others will fail. However, when agents are initially created, they have little knowledge and experience with relatively lower capability. They should also strive to adapt themselves to the changing environment. It is advantageous if they have the ability to learn and evolve. This paper addresses evolution of intelligent agents in virtual enterprises. Agent fitness and fuzzy multi-criteria decision-making approach are proposed as evolution mechanisms, and fuzzy soft goal is introduced to facilitate the evolution process. Genetic programming operators are employed to restructure agents in the proposed multi-agent evolution cycle. We conduct a series of experiments to determine the most successful strategies and to see how and when these strategies evolve depending on the context and negotiation stance of the agent's opponent.

## 1. Introduction

Doing business on the Internet is becoming more and more popular. The use of the Internet to facilitate commerce among companies and customers brings forth many benefits, such as automated transactions, greater access to buyers and sellers, and dramatically reduced costs. The agent-based e-commerce has emerged and become a focus of the next generation of e-commerce. The intelligent agent acts on behalf of customers to carry out delegated tasks automatically. They have demonstrated tremendous potential in conducting various e-commerce activities, such as comparison-shopping, auction, sales promotion, etc [1,2].

In order to solve a problem, an agent has to have certain skills and the ability to reason about these skills. We call the reasoning abilities as "mental" skills [3]. However, when agents are initially created, they have little knowledge and experience with relatively lower capability. They should also strive to adapt their negotiation strategies and tactics to the changing environment. It is advantageous if the agents have the ability to learn and evolve. Many issues are essential in agent evolution. Firstly, evolution of an agent is closely related with agent structure. Thus, a

suitable agent structure is one of basic concerns in agent evolution. Secondly, agents should have their own mechanisms for advance evolution. Thirdly, in multi-agent system, evolution of individual agent is also related with many social concerns, such as coordination, negotiation, communication, etc. Finally, some tools can be used to evaluate the fitness of agents in the evolution procedures.. In this paper, we address multi-agent evolution for agents in e-commerce. Section 2 summarizes our service-oriented negotiation model based on fuzzy theory and the BDI model. In Section 3, we adopt an evolutionary approach in which strategies and tactics correspond to the genetic material in a genetic algorithm. In Section 4, we present an empirical study showing the relative success of different strategies against different types of opponent in different environments. Section 5 contains our conclusion.

## 2. The Service-oriented Negotiation Model

This paper addresses evolution of intelligent agents about the mental skills. Obviously, there is no limit to what one would like to include under what we call mental skills. We agree that BDI model [4,5,6] provides a simple but powerful formalism for the representation, the specification and the analysis of the mental attributes of intelligent agent: belief, desire and intention

### 2.1 The BDI Model

In the BDI architecture an agent can be completely specified by the events that it can perceive, the actions it may perform, the beliefs it may hold, the goals it may adopt, and the plans that give rise to its intentions [7]. The figure 1 represents the relationships of BDI model.

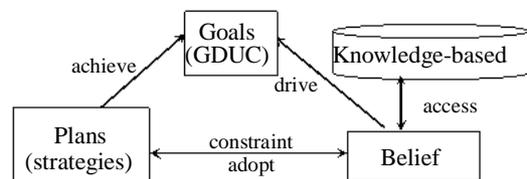


Figure 1: The BDI model of Agent

A belief model describes the information about the environment and internal state that an agent of that class may hold, and the strategies and tactics it may perform. A goal model (desires) describes the goals that an agent may possibly adopt, and the events to which it can respond. It consists of a goal set which specifies the goal and event

domain and one or more goal states – sets of ground goals – used to specify an agent’s initial mental state. There are soft and rigid goals specified by the users. We use fuzzy logic to represent the goals [8].

A plan model (intensions) describes the plans that an agent may possibly employ to achieve its goals. A plan is a sequence of strategies through reasoning mechanism (mental skills of the agent). The strategy is the combination of tactics with various weights.

### 2.2 The Goal-driven Analysis

To model user the BDI model, we use GDUC (goal-driven use case) approach [9] to structure the goals hierarchy and to analyze the plans or strategies achieving these goals. The steps describe below.

- (1) Identify actors and user’s goals to construct belief model: First, we must analyze the organization of enterprise or the environment of e-commerce to extract the basic knowledge for the agent. The knowledge can be build into a general common ontology. We also identify the users and their preferences to build the specific user-defined ontology. The ontology hierarchy can be stored into the knowledge-based of belief model.
- (2) Analyze goal hierarchy to build goal model: A faceted classification is proposed for identifying goals from domain descriptions and system requirements. Each goal can be classified under three facets we have identified: competence, view and content. The facet of competence is related to whether a goal is completely satisfied or only to a degree. A rigid goal describes a minimum requirement for a target system, which is required to be satisfied utterly. A soft goal describes a desirable property for a target system, and can be satisfied to a degree. The facet of view concerns whether a goal is actor-specific or system-specific. Actor-specific goals are objectives of an actor in using a system; meanwhile, system-specific goals are requirements on services that the system provides. We use the “use case” to structure goals hierarchy.
- (3) Analyze goal model to build plan model: According to the user’s goal and use cases, we can construct the scenarios of use cases and the possible planes to achieve the goals. Then we also evaluate the degrees of satisfaction about the planes. The ability of context sensitivity and evolution help agent adopt the negotiation strategies to achieve user’s goals.

### 2.3 Applying Fuzzy Theory to BDI Model

To model user goals, we apply GDUC to get a set of soft and rigid goals, a set of use cases, and a set of planes. For achieving these goals, agent must use particular strategies to change their mental states. We can continuously change the problem state to achieve the goal state. Thus we can apply the soft requirement [10] to formally represent the user goals.

A user goal,  $g$ , is specified by the properties of

agent’s mental state-transition  $\langle b, g, a \rangle$ , where  $b$  is the state before a plan, and  $a$  is the state after invoking the plan. A plan or strategy can thus be specified using a pair  $\langle \text{precondition, post-condition} \rangle$ . The precondition and the post-condition describe properties that should be held by the state  $b$  and  $a$ . A rigid goal describes state properties that must be satisfied. The soft goal describes state properties that can be satisfied to a degree. We use Zadeh’s test-score semantic [11] to represent the user goals. A basic idea underlies test-score semantics is that a proposition  $p$  in a natural language may be viewed as a collection of elastic constraints,  $C_1, \dots, C_k$ , which restricts the values of a collection of variables  $X = (X_1, \dots, X_n)$ . In fuzzy logic, this is accomplished by representing  $p$  in the canonical form:

$$G \Rightarrow R(P) \text{ IS } A \tag{1}$$

in which  $A$  is a fuzzy predicate. The canonical form  $G$  implies that the possibility distribution of  $R(P)$  is equivalent of the membership function of  $A$ , namely  $\Pi_{R(P)} = \mu_A$ . For example, the agent helps a user to buy high quality item and can be represented using the canonical form below:

$$G \Rightarrow \text{Quality}(\text{goods}) \text{ IS HIGH} \tag{2}$$

Where  $\text{HIGH}$  is a fuzzy predicate. The rigid goal is the specialization of the soft goal, which membership function of fuzzy predicate is 1.0.

### 2.4 The Negotiation Strategies

A negotiation strategy is the combination of tactics with various weights. A tactic generates a value for a single negotiation issue based upon a single criterion (e.g. time remaining, resource remaining).

As negotiation proceeds, the goals of agent may become relevant and the relative importance of existing criteria may vary. To reflect this fact, an agent has a strategy that varies the weights of the different tactics over time in response to various environmental. We extended the research [12,13] to proposed four types of tactics described below.

- (1) Time-dependent tactics

These tactics model the fact that the agent is likely to concede more rapidly as the negotiation deadline approaches. The negotiation must have completed at the pre-established deadline ( $t_{\max}$ ). The maximum price is  $P_r$ . When the deadline is nearly up, the price approaches the  $P_r$ . The function of tactics:

$$f_t = \alpha_t(t) P_r \tag{3}$$

$$\alpha_t(t) = k_t + (1 - k_t) \left( \frac{t}{t_{\max}} \right)^{1/\beta_t}$$

$$0 \leq \alpha_t(t) \leq 1, \alpha_t(0) = k_t, \alpha_t(t_{\max}) = 1,$$

$$0 \leq k_t \leq 1, 1/200 \leq \beta_t \leq 1000.$$

- (2) Resources-dependent tactics

These tactics generate offers depending on how a particular resource is being consumed; they become

progressively more conciliatory as the quantity of resource diminishes. Here, we use the bidder tactics. The equation is:

$$f_r = \alpha_r(t) P_r. \quad (4)$$

$$\alpha_r(t) = k_r + (1 - k_r) \frac{c(t)}{|A|} \frac{1}{\beta_r}$$

$$0 \leq k_r \leq 1, 1/200 \leq \beta_r \leq 1000.$$

$c(t)$  is the number of web at 0~t,  $|A|$  is the number of active bidding web at 0 ~  $t_{max}$ .

### (3) Prices-dependent tactics

Agent uses these tactics to maintain the goal of minimum price. Agent must get the bidding prices of all active bidding webs. The equation is:

$$f_p = \omega(t) + \alpha_p(t)(P_r - \omega(t)) \quad (5)$$

$$\alpha_p(t) = k_p + (1 - k_p) \frac{t}{t_{max}} \frac{1}{\beta_p}$$

$$0.1 \leq k_p \leq 0.3, 1/200 \leq \beta_p \leq 0.5$$

$$\omega(t) = \frac{1}{|L(t)|} \sum_{1 \leq i \leq |L(t)|} \frac{t - \sigma_i}{|\eta_i - \sigma_i|} v_i(t)$$

$|L(t)|$  is the number of active bidding webs at time t. The  $\eta_i$  represents the start time of the  $i$ th bidding web. The  $\sigma_i$  is the end time of the  $i$ th bidding web. The  $v_i(t)$  represents the highest price of the  $i$ th bidding web at time t.

### (4) Desire-dependent tactics

Agent does the best to buy the high quality goods to achieve the user desired. The curve of the price will quickly approach the  $P_r$ . The equation is:

$$f_d = \omega(t) + \alpha_d(t)(P_r - \omega(t)) \quad (6)$$

$$\alpha_d(t) = k_d + (1 - k_d) \frac{t}{t_{max}} \frac{1}{\beta_d}$$

$$0.7 \leq k_p \leq 0.9, 1.67 \leq \beta_d \leq 1000$$

## 3. The Evolution of Intelligent Agent

Genetic algorithm (GA) operators are employed to restructure agents in the proposed multi-agent evolution cycle. How to encode a solution of the problem into a chromosome is a key issue for genetic algorithms. In Holland's work [14] encoding is carried out using binary strings. For many GA applications, the simple GA was difficult to apply directly because the binary string is not a natural coding. During the past ten years, various non-string encoding techniques have been created for particular problems, for example, real number coding for constrained optimization problems and integer coding for combinatorial optimization problems. In our research, a real-coded GA uses floating-point numbers to represent

genes [15].

### 3.1 Coding Schema

In order to find proper intelligent agent, the agent's negotiation strategies are coded and represent an individual. A strategy that is the combination of tactics with various weights will determine the bidding price at time t. We have three categories of tactics: time-dependent, resource-dependent, behavior-dependent. The equation of a strategy describes below:

$$S(t) = w_t f_t + w_r f_r + w_p f_p + w_d f_d \quad (7)$$

$$0 \leq w_t, w_r, w_p, w_d \leq 1,$$

$$w_t + w_r + w_p + w_d = 1$$

Each agent is represented as a string of fixed length. The bits of the string (the gene) represent the parameters of the agent's strategy.

$$G = (t_{max}, d, r, k_1, \beta_1, w_1, k_2, \beta_2, w_2, k_3, \beta_3, w_3, k_4, \beta_4, w_4) \quad (8)$$

### 3.2 Measuring a Strategy's Fitness

A fitness function is the survival arbiter for individuals. For finding the near-optimal intelligent agent, we propose the fuzzy multi-criteria decision-making (FMCDM) approach as the evolution mechanisms, and the fuzzy soft goals to facilitate the evolution process.

We may analyze the user's goals into a goal model. Each goal can have some criteria. The evaluation of soft goal is a satisfaction degree. The relationships between goals will exist conflicting and cooperative. Most of the existing approaches in multiple criteria making lack the aspect of an explicit modeling of relationships between goals. Carlsson and Fuller [16] advocated that much closer to MCDM in the real world than the traditional MCDM are the case with interdependent criteria. Our previous work on Criteria Trade-off Analysis (CTA) has been on the formulation of soft criteria based on Zadeh's canonical form in test-score semantics and an extension of the notion of soft condition [17]. The trade-off among soft goals is analyzed by identifying the relationships between goals. A compromise overall satisfaction degree can be obtained through the aggregation of individual goal based on the goals hierarchy. The steps describe below.

(1) To compute the relationship between goals: The  $c$ ,  $c'$  are two soft goal, and  $a$  is the strategy, CF and CP denote the set of conflicting and cooperative pairs. AP denotes the set of all pairs. The conflicting and cooperative degree between two goals is defined as:

$$cf(c, c') = \frac{\sum_{(ai, aj) \in CF} (|\mu^c(ai) - \mu^{c'}(aj)| + |\mu^{c'}(ai) - \mu^c(aj)|)}{\sum_{(ai, aj) \in AP} (|\mu^c(ai) - \mu^{c'}(aj)| + |\mu^{c'}(ai) - \mu^c(aj)|)} \quad (9)$$

$$cp(c, c') = \frac{\sum_{(ai, aj) \in CP} (|\mu^c(ai) - \mu^{c'}(aj)| + |\mu^{c'}(ai) - \mu^c(aj)|)}{\sum_{(ai, aj) \in AP} (|\mu^c(ai) - \mu^{c'}(aj)| + |\mu^{c'}(ai) - \mu^c(aj)|)} \quad (10)$$

- (2) To covert connections of the goals into DNF (Disjunctive Normal Form), and to establish a goals hierarchy: We assume that goals specified by users are connected by linguistic connectives in natural language. To take these connectives into account, we proposed the use of DNF to obtain a uniform representation of the goals. According to the conflicting and cooperative degrees, a goals hierarchy of n levels is defined as a tree. This tree is important in the sense that the ordering established through the hierarchy helps alleviate the associative problem inherited in fuzzy aggregation operator.
- (3) By using fuzzy aggregation operator to compute the strategy's fitness: An extended goals hierarchical aggregation structure is proposed to facilitate goals aggregation through the fuzzy and / or operator. The fitness can be obtained through the aggregation of satisfaction degrees based on the aggregation structure.

### 3.3 The Evolution Steps

All GAs use some form of mechanism to chose which individuals from the current population should go into the mating pool that forms the basis of the next population generation. A selection mechanism known to work well in such circumstances is Tournament Selection [18]. The crossover process exchanges genetic material between individuals. We randomly select two individuals from the population. Crossover points are then randomly chosen and sorted in ascending order. Then the genes between successive crossover points are alternately exchanged between the individuals, with a probability. Mutation process works by randomly selecting some of the genes present in the population in order to mutate.

The evolution of agent describes below.

#### (1) Initial population

A GA requires a population of potential solutions to be initialized at the beginning of the GA process. Here, we randomly generate some genes to create the initial population. We also generate some genes based on the agent's belief model.

#### (2) Selection Procedure

Selection procedure may create a new good population for the next generation based on either all parents and offspring or part of them [19,20]. A sampling space is characterized by two factors: size and ingredient (parent or offspring). In regular sampling, there are several replacement strategies to replace old parents with offspring when new offspring are produced. As mentioned before, the population of next generation was formed by roulette wheel selection [19]. When selection performs on enlarged sampling space, both parents and offspring have the same chance of competing for survival. An evident advantage of this approach is that we can improve GA performance by increasing the crossover and mutation rates. We don't worry that the high rate will introduce too much random perturbation if selection is performed on

enlarged sampling space.

A reproduction operation allows strings that with higher fitness values would have larger number of copies while the strings with lower fitness values have a relatively smaller number of copies or even none at all. This is an artificial version of natural selection (strings with higher fitness values will have more chances to survive). For example, suppose that N strings are generated, and the fitness value of the ith individual string is  $f_i$  ( $i=1, \dots, N$ ). Then, the probability of the ith individual string to be selected into the mating pool is

$$P_i = \frac{f_i}{\sum_{i=1}^N f_i}, \quad (11)$$

and the number of copies for the individual string is calculated by

$$n_i = N \cdot P_i \quad (12)$$

This strategy emphasizes the survival-of-the-fitness aspects of the GA. The better strings receive more copies and go into the mating pool so that their desirable characters may be passed onto their offspring.

#### (3) Crossover

Crossover is a process to provide a mechanism for two high-fitness strings (parents) to produce two offspring by matching their desirable qualities through a random process [21]. The procedure of crossover is to select a pair of strings from the mating pool at random, then, an integer position k (called the crossover point) along the string is selected uniformly at random between 1 and (l-1), where l is the string length greater than 1. Finally, according to the probability of crossover, two new strings are generated by swapping all characters between position (k+1) and l inclusively. For example, consider two strings A and B of the population are mated for crossover

A=011|11001  
B=100|10011

Suppose we obtain k=3 as indicated by the separator symbol "|". The resulting crossover yields two new strings as shown below

A'=01110011  
B'=10011001

where A' and B' are the strings of the new generation. Although the crossover is done by random selection, it is not the same as a random search through the search space. Since it is based on the reproduction process, it is an effective means of exchanging information and combining portions of high-fitness solutions.

An agent is composed of some kinds of modules. Each module has a special feature for a particular plan. In multi-agent system, there are two phase of crossover: the inter-agent and intra-agent. With the inter-agent crossover, an agent exchanges a module with another agent. The intra-agent crossover exchanges some parameters or strategies between modules in the same agent.

#### (4) Mutation

Mutation is a process to provide an occasional random alteration of the value at a particular string

position [22]. In the case of binary string, this simply means changing the state of a bit from 1 to 0 and vice versa. A uniform mutation is first to produce a mask randomly, then change the selected string value in the position of mask where the bit value is "1". For example, consider the following selected string and generated mask:

A' = 0 1 1 1 0 0

mask M = 1 0 0 1 0 1

then, the 0-1 pattern of the string becomes as the following string,

A'' = 1 1 1 1 0 0.

Mutation occurs with a small probability in the GA to reflect the small rate of mutation existing in the real world. Mutation is needed because some digits at a particular position in all strings may be eliminated during the reproduction and crossover operations. Such a situation is impossible to be recovered by using only reproduction and crossover operations. To ensure that reproduction and crossover do not lose some potentially useful genetic materials (1's or 0's at particular locations), in mutation phase, some bits will be changed in all the strings according to the mutation rate ( $P_m$ ). In general, the mutation rate is less than 0.05. So the mutation plays a role as a safeguard in GA. It can help GA to avoid the possibility of mistaking a local optimum for a global optimum.

## 4. Experiments and Results

Over the last few years, the number of online auction houses has increased tremendously. To date there are more than 760 auction houses that conduct business online. Some examples of popular online auction house include eBay, Amazon, Yahoo! Auction, Priceline, Ubid, and FirstAuction. The types of auction that are conducted vary from site to site, but the most popular one are English, first-price sealed bid. In the English auction, the auctioneer begins with the lowest acceptable price and bidders are free to raise their bids successively until there are no more offers to raise the bid. The winning bidder is the one with the highest bid [23].

### 4.1 The Simulation Environment

In this paper, a digit video is the target item. The  $P$  is its reservation price for the target item. The bidder is given a deadline by when it needs to obtain the item. There are five predefined auctions running in the environment. These auctions have a finite start time and duration generated randomly from a standard probability distribution. The start time and the end time vary from one auction to another. The auction starts with a predefined small starting value. The process is repeated until the reservation price is reached or until the end time for the auction is reached. At the start of each auction, a group of random bidders are generated to simulate other auction participants. These participants operate in a single auction and have the intention of buying the target item and possessing certain behavior. They maintain information about the item they wish to purchase, their private

valuation of the item (reservation price), the starting bid value and their bid increment. These values are generated randomly from a standard probability distribution. They start bidding at starting bid value; when making a counter offer, they add their bid increment to the current offer, and they stop bidding when they acquire the item or when their reservation price is reached.

### 4.2 The Strategy of the Bidder Agent

The bidder agent is allowed to bid in any of the auction at any time when the marketplace is active. The objective of the bidder agent is to participate across the multiple auctions, bid in the auctions and deliver the item to its consumer in a manner that is consistent with their preferences. The bidder agent utilizes the available information to make its bidding decision; this includes the user's reservation price, the time it has left to acquire the item, the current offer of each individual auction, and its set of tactics and strategies. The output of the bidding decision is the auction the agent should bid in and the recommended bid value that it should bid in that auction. The agent's overall behavior is the amalgamation of those strategies proposed in this paper, weighted by their relative importance to the user. Mapping this to an auction environment, the bidder agent needs to decide the new bid value based on the current offer price. Let  $t$  be the current universal time across all auctions, where  $t \in \tau$ , and  $\tau$  is a set of finite time intervals. Let  $t_{max}$  be the time by when the agent must obtain the good (i.e.  $t_{max} \geq t \geq 0$ ), and let  $A$  be the list of all the auctions that will be active before time  $t_{max}$ . At any time  $t$ , there is a set of active auctions  $L(t)$  where  $L(t) \subset A$ . Since each auction has a different start and end time, the bidder agent needs to build an active auction list to keep track of all the auction that are currently active in the marketplace. The agent identifies all the active auctions and gathers relevant information about them. It then calculates the maximum bid it is willing to make at the current time using the agent's strategy. Based on the value of the current maximum bid, the agent selects the potential auctions in which it can bid and calculates what it should bid at this time in each such auction. The auction and corresponding bid with the highest expected utility is selected from the potential auctions as the target auction. Finally, the agent bids in the target auction.

### 4.3 Experimental Evaluation

Our experiments were run in an environment with 10 agents of the first generation,  $n_{max} = 100$ , 5 English auctions running concurrently, and for each auction, there are 10 participants. If the reservation price of the agent is reached or until the end time for the all auction is reached, we can get the bidding price, the bidding time, and the quality of the target item for each agent. We apply the fuzzy decision making approach to compute the fitness value of agent. Then we apply the evolution approach to generate the next generation agents. In this particular experiment, the mutation rate is 0.02. The simulations stop when the

population is stable (95% of the individuals have the same fitness) or the number of iterations is bigger than a predetermined maximum (200 in our case).

## 5. Conclusion

In this paper, we present a new approach for evolving intelligent agents in e-commerce. A goal-driven approach can construct the user's soft and rigid goals based on fuzzy set theory. The proposed BDI model represents the mental skills of the intelligent agent, including belief, desire, intention, and strategy. A FMCDM approach is applied to evaluate the agent's strategy. Agent fitness and life cycle are proposed to facilitate and control the process of agent evolution. We construct multi-agent evolution cycle, which includes states of restructuring, selection, and growing. We conduct a series of experiments to determine the most successful strategies and to see how and when these strategies evolve depending on the context and negotiation stance of the agent's opponent. Finally, we have demonstrated the usefulness of agents employing a cocktail of tactics – both for different negotiation issues and, in combination, for a single issue.

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## References

- [1] R.H. Guttman, and P. Maes. Agent-mediated negotiation for retail electronic commerce. In *Agent-mediated Electronic Commerce: First International Workshop on Agent Mediated Electronic Trading*, Berlin: Springer, pp. 70-90, 1999.
- [2] T.H. Wang, S.U. Guan, and S.H. Ong. An agent-based auction service for electronic commerce. In *Proceedings of International ICSC Symposium on Interactive and Collaborative Computing*, Australia, 2000.
- [3] D. C-H Han and N. Parameswaran. Multi Agent Problem Solving with Mental States. *IEEE*, pp. 288-292. 1994.
- [4] P. Cohen and H.J. Levesque. Intention is Choice with Commitment. *Artificial Intelligence*, 42(3): pp. 213-216, 1990.
- [5] R. Fagin, J. Halpern, Y. Moses, and M. Vardi. *Reasoning About Knowledge*. MIT Press, 1995.
- [6] A. Rao and M. Georgeff. Modeling rational agents within a BDI architecture. J. Allen, R. Fikes, and E. Sandewall (editors). KR-91. Morgan Kaufmann, 1991.
- [7] M. Barbuceanu and M.S. Fox. COOL: A language for describing coordination in multi-agent systems. In *Proceedings of the International Conference on Multi-Agent Systems, ICMAS-95*, San Francisco, CA, 1995.
- [8] J. Lee and J.Y. Kuo. New approach to requirements trade-off analysis for complex systems. *IEEE Transactions on Knowledge and Data Engineering*, 10 (4): 551-562. 1998.
- [9] J. Lee, N.L. Xue and J.Y. Kuo. February 2001. Structuring Requirement Specifications with Goals. *Information and Software Technology*, Vol. 43, pp. 121-135.
- [10] J. Lee, J. Y. Kuo and A. Liu. Modeling User Requirements with a Front-end Analysis. *International Journal on Artificial Intelligence Tools*, 6(3): 313-324, Sep. 1997.
- [11] L.A. Zadeh. Test-score Semantics as a Basis for a Computational Approach to the Representation of Meaning. *Literary Linguistic Computing*, 1:24, 1986.
- [12] P. Anthony, W. Hall, V. Dung, N.R. Jennings. Autonomous for Participating in Multiple Online Auctions. *Proceedings IJCAI Workshop on E-Business and the Intelligent Web*, Seattle, WA, pp. 54-64, 2001.
- [13] N. Matos, C. Sierra and N. R. Jennings. Determining successful negotiation strategies: an evolutionary approach. *Proceedings 3rd Int. Conf. on Multi-Agent Systems (ICMAS-98)*, Paris, France, pp. 182-189, 1998.
- [14] J. Backer, "Adaptive Selection Methods for Genetic Algorithms", *Proceedings ISCGA*, pp. 100-111. 1994.
- [15] M. Michalewicz, *Genetic Algorithms + Data Structure = Evolution Program*, Springer-Verlag, Berlin, 1992.
- [16] C. Carlsson and R. Fuller. Interdependence in fuzzy multiple objective programming. *Fuzzy Sets and System*, 65:19-29, 1994.
- [17] J. Lee and J.Y. Kuo. Fuzzy decision making through trade-off analysis between criteria. *Information Sciences*, 107(1-4): 107-126. 1998.
- [18] D. Goldberg. *Genetic Algorithms in Search Optimization and Matching Learning*. Addison-Wesley. 1989.
- [19] Baker, J.B., "Adaptive Selection Methods for Genetic Algorithms", *Proceedings of the First International Conference on Genetic Algorithms*, pp.101~111, 1985.
- [20] D. Goldberg. *Genetic Algorithms in Search. Optimization and Matching Learning*. Addison- Wesley. 1989.
- [21] Chen, T.Y. and Chen, C.J., "Improvements of Simple Genetic Algorithm in Structural Design", *International Journal for Numerical Methods in Engineering*, Vol.40, pp.1323-1334, 1997.
- [22] Z. Michalewicz, T. Logan, and S. Swaminath. Evolutionary Operators for Continuous Convex Parameter Spaces", In *Proceedings of the 3rd annual Conference on Evolutionary Programming*. World Scientific, pp. 84-97, 1994.
- [23] R. P. McAfee and J. McMillan. Bidding rings. *American Economic Review*, Vol. 82 No. 3. pp. 579-599. 1992.

# Overcoming the Fixed-Pie Bias in Multi- Issue Negotiation

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## Abstract

Multi-issue negotiation may produce mutual beneficial results to both negotiators while single-issue negotiation can not. However, there are difficulties in automating a multi-issue negotiation, since the search space grows dramatically as the number of issues increases. Although many concession strategy learning mechanisms have been proposed to deal with the problem, recent research uncovered that the fixed strategy of concession and the fixed-pie bias are the two major interferences in the automation of multi-issue negotiation. It is suggested that the lack of communication between agents may have impeded information sharing and joint-problem solving possibilities.

In this paper, we show that the fixed-pie bias can interfere with the negotiation outcome if there are non-conflicting issues. We propose a new negotiation model and an innovative algorithm that not only allows information to be shared in a controlled way, but also allows the information shared to be effectively used for conducting a systematic search over the negotiation problem space. The combined mechanism is capable of using strategies learned from counter-offers and is immune to the fixed-strategy limitation and the fixed-pie bias. It contributes to the automation of multi-issue negotiation in the context of open and dynamic environments.

## 1. Introduction

Negotiation is a human behavior existed since there is trade. People exchange products in order to give out what they have for what they need. In the age of electronic commerce, negotiation has been automated by software agents or supported by negotiation support systems (NSS). Research [10] [16] [11] [5] indicated that these automation mechanisms were able to reduce significantly the negotiation time and alleviate the negative effects of human cognitive bias and limitation. The evolution went from single-issue negotiation to multi-issue negotiation. In a single-issue negotiation, the term negotiated is limited to price. Although this kind of negotiation works for some cases such as auction houses, most companies on the Internet are generally against it since it brings out price wars that not only causes chaos in markets but also ignores the importance of other issues such as warranty period and delivery time.

Multi-issue negotiation becomes an important research area in the e-commerce domain, since it is more

beneficial comparing to single-issue negotiation [14]. However, there are difficulties in automating a multi-issue negotiation. Take a bilateral multi-issue negotiation, where there is a buyer and a seller performing a one-to-one negotiation, for example. Issues can be negotiated sequentially or simultaneously. The issue-by-issue approach suffers the drawback of being unable (or costly) to go back to already negotiated issues. Hence it is inappropriate for solving problems with inter-dependent issues. In the simultaneous approach, on the other hand, negotiators get lost easily in the complex decision tree of concessions, and the search space grows dramatically as the number of issues increases. Since we assume self-interested agents, an agent will not disclose his utility function, being afraid of the fact that the opponent will take advantage of it to squeeze surplus out of him. Given the situation, the only information disclosed are the offers proposed and the information of acceptance or rejection on the proposed offers. An algorithm is required to search the negotiation problem space for mutual beneficial agreements base on the limited information. Adopting the simultaneous approach, there are three types of algorithms:

1. Brute force: suppose that a buyer is bidding for goods from a seller. He then queries the seller for acceptance of each offer in mind, from the one with highest utility to the one with lowest. The seller may accept it or reject it. This process continues until the buyer has run out of alternatives. To speed up the process, the seller can counter-offer using the same method as the buyer. Once an offer is accepted by one of two players, the negotiation ends. This approach is similar to the continuous double auction used in Kasbah [2], and may work fine in the single-issue negotiation without time constraints (i.e. deadline, bargaining cost, etc.). However, it is hardly applicable to the multi-issue negotiation since there are generally too many alternatives generated by combining options of all the issues. Simply generating and sorting them will require a lot of memory space, not to mention querying them one by one, which can be very time-consuming.

2. Use a concession strategy learned from past negotiations: this approach works great if the market is static, which means that the general utility function of buyers/sellers does not change radically over time. Although we do not know exactly the utility function of the opponent, we learn from past negotiations to get the best concession strategy that can both speed up the negotiation and get better outcomes. However, if the

market is dynamic, this fixed strategy may not achieve mutually beneficial outcomes each time, since different opponents may have quite different utility functions over the various issues. Research [13] [12] [17] belongs to this type.

3. Use a concession strategy learned from counter offers: although rarely seen in the research, it is possible to learn a concession strategy from counter offers within a negotiation session. The rationale behind it is to find out which terms are important (weighted more in the utility) to the opponent, but less important to us. Conceding on these issues increases the possibility of being accepted by the opponent, while preserving our interests. Research [4] uses similarity criteria to make issue trade-offs; it is believed that by making an offer similar to the one by the opponent can approximate the preference structure of the opponent.

In an open and dynamic environment, such as the Internet, the third type algorithm becomes important. Goh et al. [6] conducted an experimental study on computer-supported bargaining in the context of electronic commerce, and uncovered that the fixed strategy of concession and the fixed pie bias are the two major interferences in the automation of negotiation. It is suggested that the lack of communication between agents may have impeded information sharing and joint-problem solving possibilities. The problem of fixed strategy has been addressed later in [4] (though the existence of too many assumptions has caused their research to be less applicable to real cases). However, the joint-problem solving possibilities are still constrained by the fixed-pie bias and the information shared.

In this paper, we propose a new negotiation model and an innovative algorithm that not only allows information to be shared in a controlled way, but also allows the information shared to be effectively used for conducting a systematic search over the negotiation problem space. The combined mechanism is capable of using strategies learned from counter-offers and is immune to the fixed-strategy limitation and fixed-pie bias. It contributes to the automation of multi-issue negotiation in the context of open and dynamic environments.

The sections are organized as follows: section 2 firstly explains the rationale for information sharing. Section 3 describes the negotiation model used, and section 4 gives details of the searching algorithm. Section 5 contains experimental analysis and finally the conclusion and future work is presented in section 6.

## 2. The Rationale for Information Sharing

In the context of Game Theory, the two-player bargaining game is defined as a non-cooperative game where two players attempt to divide a good, say a pie, between them. However, the pie-dividing concept may introduce the fixed-pie bias, which is a tendency for negotiators to assume that their own interests directly conflict with those of the other party [1] [18]. The problem caused by this bias seldom occurs in a bargaining since

most of them are dealing with conflicting issues. Let us consider a more general two-player multi-issue negotiation problem, where the players not only negotiate for the price, but also a date for delivering the product. The utility gained from settling for a different date is illustrated in Figure 1. At the beginning, their preferences seemed to be conflicting; nevertheless, they managed to meet at day 7, which is the best solution for both of them. The  $f$  curve occurs when a player wishes to get the product immediately or on a later date if he can not get it immediately. This example illustrates that sometimes the pie-dividing concept may be misleading, causing both negotiators to neglect a mutually beneficial solution if they do not communicate. Same problems can occur when dealing with qualitative issues such as the choice of colors, since the utility gained by each color may not always be conflicting with the opponent's preference.

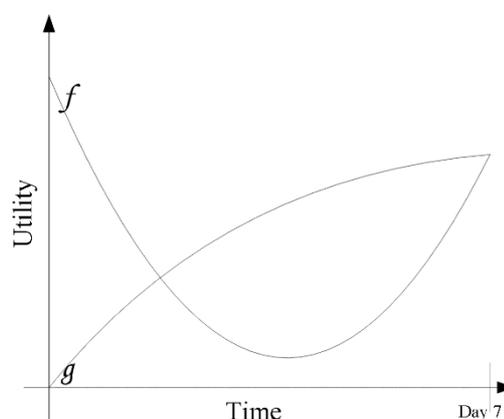


Figure 1. Non-conflicting utility case

Research [4] was based on the pie-dividing concept; however, they allow different levels of importance to be attached to various negotiation decision variables. This makes the negotiation a non-zero-sum game, where players can find mutually beneficial agreements by making trade-offs over issues instead of conceding at the utility. That is to say, by increasing some decision variables in value and decreasing some others may create an offer that will benefit one or both of the players simultaneously. However, considering the above delivery time case, we find that a mutually beneficial offer can be found by simply increasing the utility of one of the decision variables without decreasing any other (instead of conceding, one can raise the utility of the new offer). In other words, better solutions can be found if we avoid the fixed-pie bias. Nevertheless, by avoiding the fixed-pie bias, we are again lost in the enormous possible paths of solution searching. It is our belief that, by disclosing a little more information, the player with less privacy concerns can improve the negotiation outcome, and therefore benefits himself. And it is also common that, in the real life situation, a player with less privacy concerns will simply release trade-off information, such as "you can deliver the product to me immediately or a week later."

One may argue that, in the above delivery date case, the opponent will propose the offer of day 7 eventually if you did not propose it, yet in the multi-issue case, there can be a lot of alternatives that it is too hard to enumerate them all. Therefore how the information can be shared in a systematic way such that the opponent can use it to improve the solution searching process is the major concern here. Besides, the information should be disclosed in a controlled way so that it not only matches our privacy preference but also complies with our negotiation strategy. To tackle this problem, we propose a new negotiation model and an innovative solution to the searching problem in the following sections.

### 3. Tagged Multi-offer Negotiation Model

In this section we first provide an overview of our negotiation model. Then we discuss the issues of time constraints and information states.

#### 3.1 The Negotiation Model

The settings of our negotiation model are based on a non-cooperative, multi-stage, incomplete-information, and two-player bargaining game. Since this is a non-cooperative game, each player does his best to maximize his own interest and will not share information more with the other than necessary. We assume each player knows neither the other's preferences on issues, nor the utility function; therefore it is a game with incomplete information. Given such a situation, in order to reach an agreement that is beneficial to both players, the negotiation will continue for more than one stage.

Rubinstein proposed a multi-stage bargaining game [15], in which each player of the game proposes an offer in turn and the other may accept or reject it. The game will continue until an offer is accepted. Our model differs from [15] in that: Firstly, we allow multiple offers to be proposed at one time. For example, a seller can propose two offers at one time, saying "you can buy product A at price B with delivery time C or buy product A at price D with delivery time E". The buyer may counter propose with sayings like "I can only buy product A at price F with delivery time G or buy product A at price H with delivery time K". This relaxation of multiple alternating offers enables a player to disclose possible trade-off information over which the opponent can consider. It can speed up the searching process and avoid falling into local optima in the solution landscape too early.

Besides the relaxation of multiple alternating offers, we allow players to tag information of their preferences over proposed offers. For example, a vector  $\langle\langle A, 3 \rangle, \langle B, 2 \rangle, \langle C, 1 \rangle\rangle$  indicates that offer A is the most preferred, offer B is the second most preferred, while offer C is the least preferred. We allow the multiple alternating offers and the tagging of preference information because we believe the information may be "necessary" for both players to reach an agreement that is beneficial to both of them. However, how much information will be shared is a

decision made by the players. An elegant controlling mechanism is embedded in our searching algorithm (detailed in the next section), and it can be tuned according to the privacy preference of the player.

Finally, the negotiation game will end in a known period of time, no matter whether an agreement has been reached. If an agreement has been reached before the deadline, the players will continue to improve it until the deadline. If no agreement has been reached before the deadline, the negotiation fails. If more than one agreement has been reached, the latest one is chosen. This design permits better solutions to be found after the first agreement has been reached.

We name this negotiation model a TAMON (TAGged Multi-Offer Negotiation) model.

#### 3.2 Time Constraints

Rubinstein's model has a basic assumption that 'time' is valuable during the negotiation, and the fixed bargaining cost or fixed discounting factor may affect the strategy used in the bargaining. If each player has complete information about the preferences of the other, a weaker player (i.e. the one with higher fixed bargaining cost) will always lose. However, assuming each player does not know the preference structure of the other (incomplete information), the weaker player may try to cheat the other player by making the other player believe that he is actually stronger.

To simplify the TAMON model (avoiding the consideration of time-related strategies), we assume the cost of time is negligible during a TAMON game. In other words, by choosing a reasonable period of time to play the negotiation game, it is possible for both players to agree that there can be no time constraints during the period of negotiation. By this simplification we make TAMON a micro negotiation game. It does not mean that there are no time constraints any more, but that the time constraints are omitted during the TAMON game. The time constraints still exist between the current TAMON game and the next TAMON game. That is to say, to achieve an agreement, both players can play a series of TAMON game that is time constrained.

This simplification has two benefits:

1. The environment is stable during a TAMON game; therefore players can focus on the searching and improving of solutions without the need to deal with changing environmental parameters.

2. Existed time-dependent bidding strategies such as NDF [3] can be applied directly to a series of TAMON game without conflicting with "micro" level strategies used in the TAMON game.

This assumption also indicates that the goal of micro level strategies will be to find a solution given the constraints from "macro" level strategies. And macro level strategies are applied on a series of TAMON game.

### 3.3 The Information State

Each player (let  $b$  denotes buyer and  $s$  denotes seller) in a TAMON game is modeled as a 5-tuple  $I^a$  with a utility function  $U$ , a utility threshold  $U_{\text{threshold}}$ , a degree of information sharing  $D$ , a micro level strategy  $S$  and a mutually agreed period of time  $T$  to play the game:

$$I^a = \langle U^a, U_{\text{threshold}}^a, D^a, S^a, T \rangle, \text{ where } a \in \{b, s\}. \quad (1)$$

We define the utility function to be a sum of weighted contributions of  $N$  issues:

$$U = \sum_{i=1}^N w_i * u_i, \text{ where } u_i = [0,1] \text{ and } \sum_{i=1}^N w_i = 1. \quad (2)$$

The utility contributed by each issue, however, is not necessarily depending only on the value of this specific issue, but also on the values of  $K$  other issues in the offer. The occurrences of this interdependency will make it inappropriate to be negotiated in an issue-by-issue way.

The micro level strategy  $S$  is defined by the algorithm and the algorithm parameters used for generating and accepting offers (detailed in section 5). In this paper, we will assume there is only one choice of algorithm, the BGA (discussed in the next sub-section), and  $D$  does not change during the series of TAMON game. Therefore the macro level strategies contain only functions determining the value of  $U_{\text{threshold}}$ . The search space bounded by  $U_{\text{threshold}}$  in a TAMON game is illustrated in Figure 2.

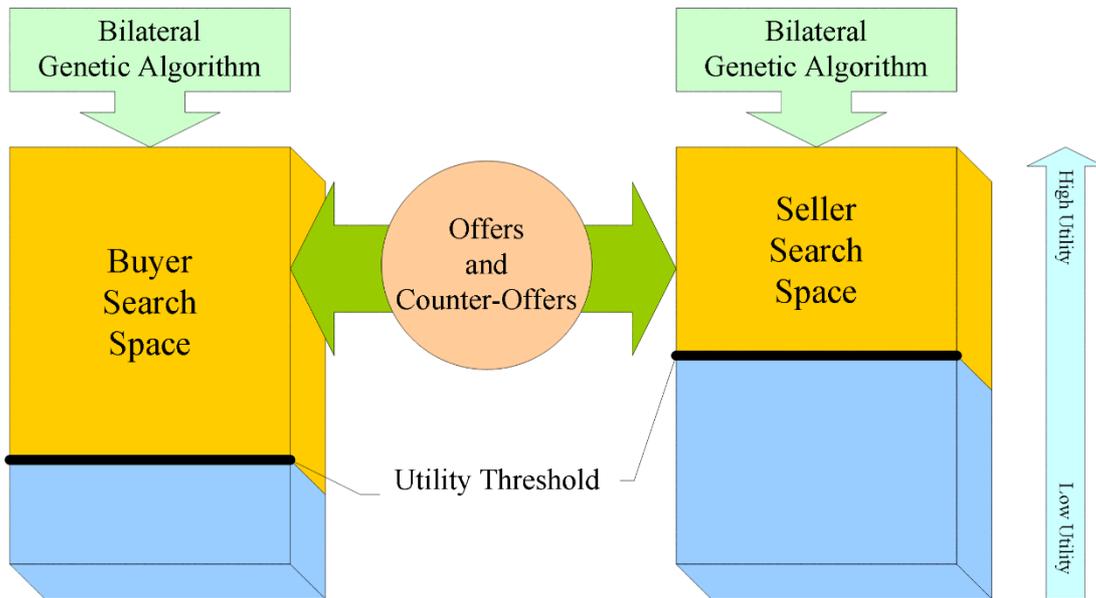


Figure 2. The Search Space in a TAMON Game

### 4. The Bilateral Genetic Algorithm

To search in the space of a TAMON game, we need a heuristic method that is computationally tractable; since the overall search space is too large that an exhaustive fashion of search is not possible. Considering a single-issue negotiation for delivery time in Figure 3, if both negotiators are using the same linear time-dependent macro level function for decreasing the  $U_{\text{threshold}}$ , their agreement can be found at the intersection of utility  $x$ . In this case, the offer generating process would be too simple that the micro level TAMON game can be set to propose only one offer in a turn and be played for only two turns (in the first turn, the buyer proposes and the seller accepts

or rejects, in the second turn the seller proposes and the buyer accepts or rejects). However, in a multi-issue search space, it is almost impossible to generate all the offers with utility  $x$  (while there are only two offers of utility  $x$  evaluated using  $f$  or  $g$  in Figure 3, there can be a huge number of offers of utility  $x$  in a multi-issue search space, especially when given nonlinear utility functions). Therefore, the searching algorithm can only propose some of them, and there is a great chance that the search algorithm will miss the right one. Suppose that a solution is guessed out at utility  $x'$  of time  $y'$  later, and then a mechanism will be required to back-search for the real optimal solution of utility  $x$ . The Bilateral Genetic Algorithm (BGA) is proposed to deal with this problem.

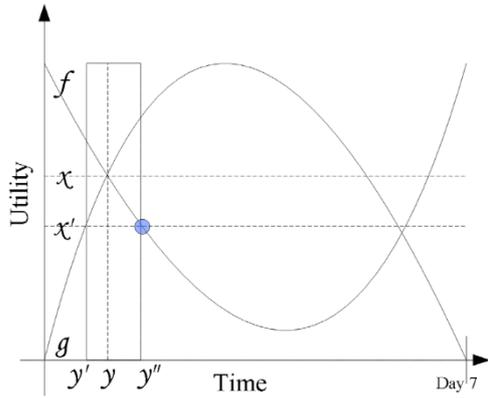


Figure 3. The Matching Point

#### 4.1 Overview of BGA

BGA is an algorithm for searching solutions to the TAMON problem. We apply the concepts of genetic algorithm (GA [8]) to the domain of offers. That is, we use a joint utility to express the fitness of an offer, and use an evolutionary approach to find out the best offer if possible. A very simple design of such an idea is to encode an offer into a single chromosome and let the fitness of it be the product (product is used instead of sum for fairness) of two utility values from the buyer and the seller. For example, let a chromosome {100, 5, 2, 3} (for readability, we use n-ary gene encoding) represents an offer with price of 100, quantity of 5 units, delivery time of 2 days and warranty period of 3 years. If the joint utility of this chromosome is high, the number of this individual will grow exponentially in the population, as stated in GA. And the population will eventually converge to the answers we want.

However, since the agents are self-interested in our scenario, each agent does not share information of his

utility with the other. Lacking the utility function from the other agent, an agent will not be able to determine the joint utility of a chromosome. Hence, both the buyer agent and the seller agent are not able to perform the selection using genetic operators on the population of offers. To overcome this problem, we propose an innovative algorithm BGA, which divides the population for evolution into a buyer side population and a seller side population, and uses two special genetic operators, B-selection and B-recombination, to handle the selection and recombination process in the presence of incomplete fitness function. Both agents must perform the genetic B-selection process and B-recombination process separately. The B-selected population will be proposed to the other player while the received population will be used to B-recombine with our B-selected population, as illustrated in Figure 4. The B-selection has a tunable sampling rate, which can select offers for proposing according to the  $D$  parameter. We will discuss the details of each operation in the following sub-sections, and then explain why it works.

Before we discuss the genetic operators used in BGA, we firstly define the parameters used in BGA:

Population Size:  $Z_{population}^a \in \mathbb{N}$ .

Crossover Rate:  $R^a = [0]1$ .

Mutation Rate:  $M^a = [0]1$ .

Chromosomes:  $C_i^a$ , where  $i \in \mathbb{N}$  and  $1 \leq i \leq Z_{population}^a$ .

Again:  $a \in \{b, s\}$ .

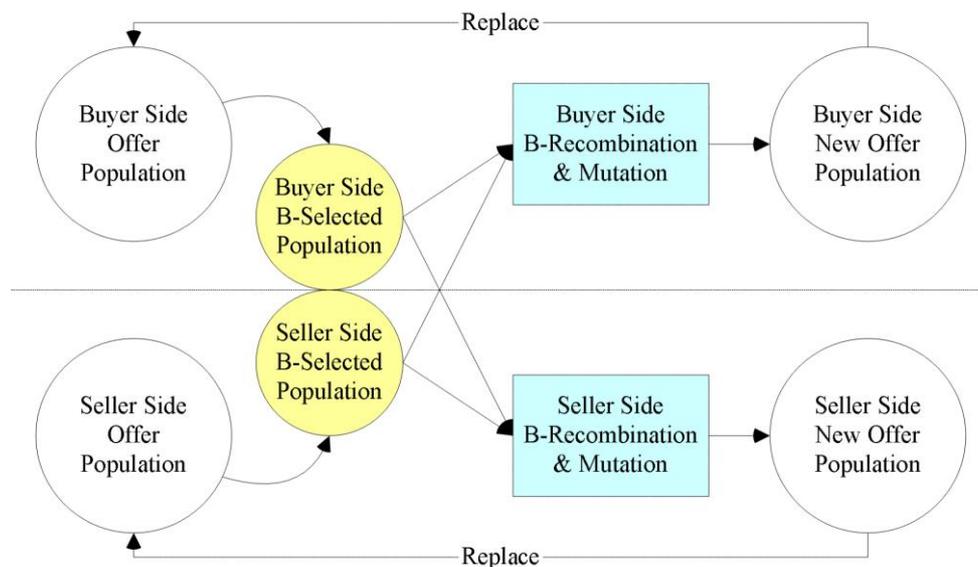


Figure 4. The BGA Evolution Process

#### 4.2 B-selection, B-recombination and B-mutation

The selection process of a GA will produce a new population with the distribution of chromosomes being proportional to the fitness of each chromosome from the old one. The one with higher fitness gets higher probability to be selected in the resulted population. B-selection does a little more: it will propose the population of chromosomes to the other agent, and the size of it will be affected by the degree of information sharing (parameter  $D$ ). The actual size of population proposed is:

$$Z_{\text{offers}} = \lfloor Z_{\text{population}} \times D \rfloor \quad (3)$$

During the agent communications, duplicated offers can be represented using a vector format  $\langle \text{Offer, Number} \rangle$ . The B-selected population then becomes offers proposed to the other player in a tagged multi-offer format. The higher value in  $D$ , the richer information in the proposed offers. If  $Z_{\text{offers}}$  equals to 1, it becomes a normal alternating offer protocol that proposes only one offer a turn.

The B-recombination operator differs from the GA recombination in that it recombines chromosomes from the different-side B-selected populations. In other words, one of the parent chromosomes comes from the buyer-side B-selected population while the other from the seller-side B-selected population. Since the population B-selected by the other agent might have different size from ours, both the received population and our B-selected population are rescaled to half of our population size before they can be put together into a joined population of size  $Z_{\text{population}}$  (see Figure 5). The joined population is then ready for B-recombination. It should be noted that, each agent might have a joined population of different size, since their  $Z_{\text{population}}$  values might be different.

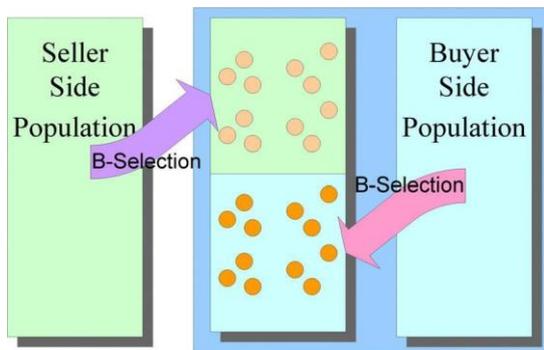


Figure 5. The Joined Population

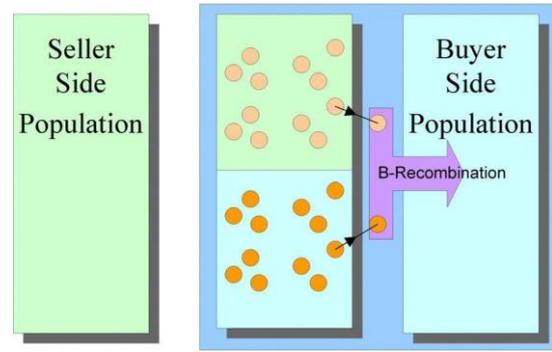


Figure 6. Performing B-recombination

B-recombination of two chromosomes produces chromosomes that represent offers applying different concession strategies. For example, recombining a buyer proposal  $\{100, 4, 2, 4\}$  with a seller proposal  $\{120, 3, 2, 2\}$  may produce a proposal  $\{100, 3, 2, 2\}$  denoting that the seller concedes at the price of value 100, and a proposal  $\{120, 4, 2, 4\}$  denoting that the seller concedes at quantity, delivery time and warranty period. Each agent performs B-recombination at his own memory space; therefore the crossover rates can be different at the two sides. After the B-mutation process, the newly generated population then replaces the old one (noted that the first generation is randomly generated). The B-mutation is similar to the GA mutation process except that it is performed separately at both sides.

We use uniform crossover in B-recombination, although it is considered to be maximally disruptive when the epistatic interactions are the nearest neighbors [9]. We believe it is required in our scenario, because it helps the B-recombination generate more possibilities of concessions assuming that the two negotiating agents may have different information spaces. For example, if the buyer can propose only one chromosome  $\{A, B, C\}$ , and the seller can propose only one chromosome  $\{D, E, F\}$ , uniform crossover makes it possible to generate a chromosome with  $\{A, E, C\}$  while one-point crossover cannot.

In the final algorithm, the B-selection is actually processed twice (Figure 7) by an agent in a turn; one for proposing offers, and one for generating half of population for next join. We need to separate these two populations since the proposed one is bounded by the utility threshold while the reserved one for next join is not. The detail of the algorithm is not explained in this paper. For interested readers, please check the web site: <http://homepage.ntu.edu.tw/~d85725004/BGA.html>.

```

GENERATE-OFFERS( $S_{pop}^r, D_{is}^r, R_{rec}^r, R_{mut}^r, b_f^r, b_u^r, \psi^r, \mu^r, \rho^r, \sigma^r, \theta^r, \vartheta^r, \chi^r$ )
1  $\chi^r \leftarrow \chi^r \cup \theta^r$ 
2 if ( $\theta^r = \phi$ ) or ( $\vartheta^r = \phi$ )
3   then  $\alpha \leftarrow \text{CREATE-POPULATION}(\rho^r, S_{pop}^r)$ 
4   else  $\alpha \leftarrow \text{B-MUTATE}(\text{B-RECOMBINE}(\text{RESCALE}(\theta^r, S_{pop}^r/2), \vartheta^r, R_{rec}^r), R_{mut}^r, \rho^r)$ 
5  $\gamma \leftarrow \text{ASSIGN-FITNESS}(\alpha, \psi^r, b_f^r)$ 
6  $\vartheta^r \leftarrow \text{B-SELECT}(\gamma, S_{pop}^r/2, 0)$ 
7  $\beta \leftarrow \text{B-SELECT}(\gamma, [S_{pop}^r \cdot D_{is}^r], b_u^r)$ 
8  $\theta^r \leftarrow \beta - \chi^r$ 
9  $\chi^r \leftarrow \chi^r \cup \theta^r$ 
10 return  $\theta^r$ 

GENERATE-FEEDBACK( $D_f^r, \theta^r, \mu^r, b_u^r, \psi^r$ )
1 if  $\sigma^r \neq \phi$ 
2   then  $b_u^r \leftarrow U(\sigma_1^r)$ 
3    $\psi^r \leftarrow \psi^r \cup \sigma^r$ 
4 if  $\theta^r \neq \phi$ 
5   then  $\gamma \leftarrow \text{AGREEMENTS}(\theta^r, \mu^r, b_u^r)$ 
6    $b_u^r \leftarrow \max\{(\gamma_j)_2 | 1 \leq j \leq \text{size-of}(\gamma)\}$ 
7    $\psi^r \leftarrow \psi^r \cup \gamma$ 
8    $\sigma^r \leftarrow \text{FEEDBACK}(\gamma, D_f^r)$ 
9 else  $\sigma^r \leftarrow \phi$ 
10 return  $\sigma^r$ 

```

Figure 7. The BGA algorithm

### 4.3 Preliminary Agreements

At the beginning of a BGA process, all chromosomes (i.e. offers) with utility higher than or equal to  $U_{\text{threshold}}$  are assigned a fitness value  $F_{\text{threshold}} = 0.99 * U_{\text{threshold}}$ . The coefficient 0.99 is designed to make the fitness value a little smaller than the  $U_{\text{threshold}}$ . Once a preliminary agreement (a proposed offer that is accepted) is reached, the associated chromosome will be given fitness equals to its real utility, which is higher than  $F_{\text{threshold}}$ . The number of this chromosome will then start to increase because of its high utility (further explained in the next sub-section). The discovery of a preliminary agreement also causes the value of  $U_{\text{threshold}}$  to climb up to the utility equaling to the one of the preliminary agreement. This climbing behavior ensures that the newly proposed offers will have a higher utility than preliminary agreements. It is the back-searching mechanism mentioned in the first paragraph of this section. In the view of macro level strategies, the value of  $U_{\text{threshold}}$  often goes down (decreasing) and does not go up, only when some preliminary agreement has been reached, it then makes sense to revert the  $U_{\text{threshold}}$  to the new high utility reached. This action is named a utility threshold reverting.

### 4.4 Implicit Parallelism in BGA

The main idea of BGA is to utilize the implicit parallelism of GA to explore all possible concession strategies and accumulate useful building blocks [7] at one

time. Implicit parallelism, named by Holland [8], is a property that:

...Even though each generation we perform computation proportional to the size of the population, we get useful processing of something like  $n^3$  schemata in parallel with no special bookkeeping or memory other than the population itself...

In BGA, only preliminary agreements contain useful building blocks that need to be accumulated in the later search. That is why we restore fitness of chromosomes to their actual utility value after they are found to be preliminary agreements (before that, all fitness values are lower than  $U_{\text{threshold}}$ ).

By B-recombining chromosomes from two populations of different sides, chromosomes representing various offer-improving possibilities are generated. The offer-improving behavior is a little bit like the similarity approximation in [4], since B-recombination try to generate an offer by recombining chromosomes from the two different populations and the resulted chromosomes will be similar to their parents. In fact, the BGA algorithm does a better job then [4] for locating offers similar to the opponent's. Because research [4] try to find similar offers by decreasing the utility distance, which is impossible if certain kinds of information about the opponent's utility function is unavailable. Their simulations work simply because there are too many assumptions (linear, conflicting, same value range and equal discrimination power over the reservation values) being placed on the opponent's utility function in their research. It makes the assumption of "incomplete information" quite weak.

B-recombination does not have a fixed-pie bias, since it does not assume a utility conceding is necessary when trying to generate an alternative. In fact, the BGA never decrease the utility of new offers, and try to increase the utility whenever possible. Once an offer acceptable to both sides is found, the utility threshold is increased, and the useful genetic information in the offer will then be accumulated in an evolutionary way.

To conclude, BGA can deal with the searching problem of a TAMON game in a computationally tractable way, and no specific assumptions are placed upon the utility function of the opponent.

### 5. Experimental Analysis

A negotiation case with mixed (including linear and nonlinear) utility function is prepared to test the capability of BGA. The utility functions for 5 issues in buying a car are listed in Table 1 (for simplicity, some of the functions are not showed in detail; mechanisms used to ensure the range of each utility value are omitted; for interested readers, complete source codes can be found at <http://homepage.ntu.edu.tw/~d85725004/BGA.html>). Two exceptions are added to override the default utility functions. They provide extra interdependency among these issues, and are the epistatic interactions as explained in [9].

Table 1. Utility functions

	Buyer	Seller
Price	$(200 - ((v \cdot v) / 200)) / 200$	$(v - 20) / 300$
Time	$\text{Cos}((2 \cdot \text{Pi} \cdot (v \bmod 7)) / 7)$	$\text{Sin}((2 \cdot \text{Pi} \cdot (v \bmod 30)) / 30)$
Type	{0.1, 0.2, 0.9, 0.5, 0.1}	$v / 4$
Color	{0.3, 0.4, 0.2, 0.7, 0.9}	{0.5, 0.5, 1, 0.5, 0.5}
Option	$(10 - v) / 10$	$v / 10$
Exceptions	If (Type = 1) and (Color = 2) then both issues get an utility value of 0.9.	If (Time = 77) and (Type = 1) then both issues get an utility value of 1.

Eighteen combinations of parameters (Table 2) are used to run the simulations. They are designed to answer the following questions:

1. Should I be the first mover? (should I propose offers firstly?)
2. How do I propose? (how much information can be disclosed?)
3. How do I response? (how much information should be fed back to the opponent regarding his proposing?)

In question 2, the degree of information sharing determines the sampling rate for proposing offers in mind, and in question 3, the feedback rate of preliminary agreements determines how much information regarding one's evaluation on the opponent's offers will be fed back to him.

Table 2. Experiment parameters

Q	Parameter Name	Parameters
1	First Mover	seller first buyer first
2	Degree of Information Sharing (DoIS for short)	1 (all) 0.1 0.0025
3	Feedback of Preliminary Agreements (FoPA)	1 (all) 0.5 0.1

As expected, the first mover has disadvantage in the TAMON game. The explanation is intuitive: since the first mover shares information firstly, the opponent is then able to increase his utility threshold firstly when preliminary agreements are found in the first turn. Readers can compare Figure 8 and Figure 9 to find out the difference (noted that the X-axis in them represents the product of DoIS and FoPA, and Y-axis the utility).

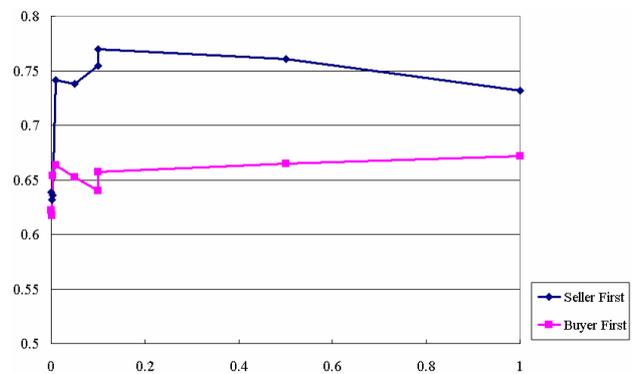


Figure 8. Buyer utility

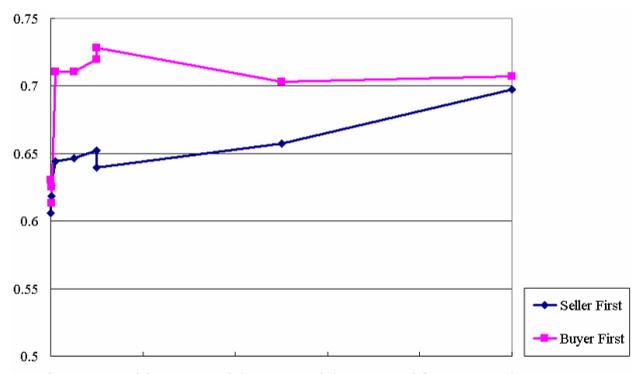


Figure 9. Seller Utility

Judging from the results showed in the following Figure 10 (FoPA = 1) and Figure 11 (DoIS = 1), we can conclude that the effects of information sharing have higher impact on the negotiation results than feedbacks. The reason lies at that the number of preliminary agreements is small comparing to the proposed offers. Since both negotiators tend to decrease the utility threshold slowly in the progress of negotiation, the number of preliminary agreements can not be very large. We also found that the degree of information sharing need

not to be very high for satisfactory negotiation results to be gained.

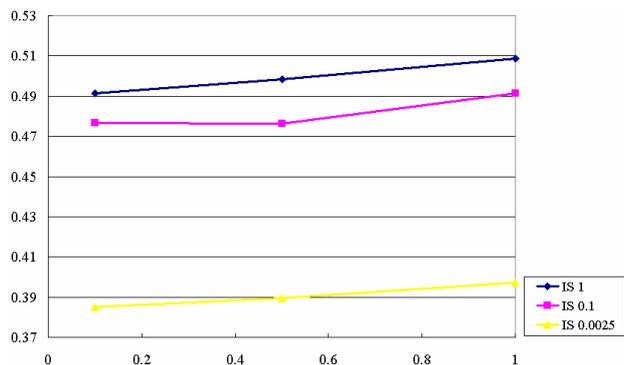


Figure 10. Effects of information sharing

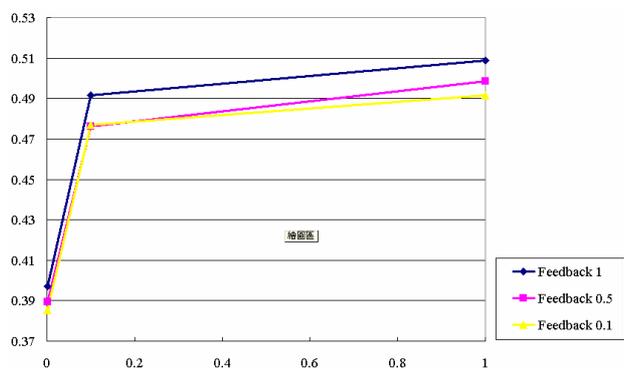


Figure 11. Effects of feedback

In Figure 12 (X-axis represents the buyer utility and Y-axis the seller utility, assuming FoPA = 1), the BGA simulation results are compared to GA simulations with same crossover rate (0.7) and mutation rate (0.02). Both population sizes are set to 400. In GA simulations, however, the algorithm has complete information of both negotiators' utility functions, and the product of buyer utility and seller utility is used as the fitness value. 1000 generations were run for the GA simulations while a period of 10 seconds was used in each micro level TAMON game simulation. We assume same bargaining power in the BGA simulations, therefore the utility threshold decreases at same speed (0.1 per micro level game) for both negotiators. Both GA and BGA simulations were run 30 times to get the average negotiation results in Table 3. The best result found by the brute force algorithm (testing all combinations) is also marked on Figure 12.

Table 3. Simulation results

	Buyer Utility * Seller Utility (Avg)	Ratio
Best	0.532946667	1
GA	0.520159512	0.976006689
BGA-1	0.508617115	0.954348993
BGA-0.5	0.491376085	0.921998608
BGA-0.0025	0.397237238	0.745360207

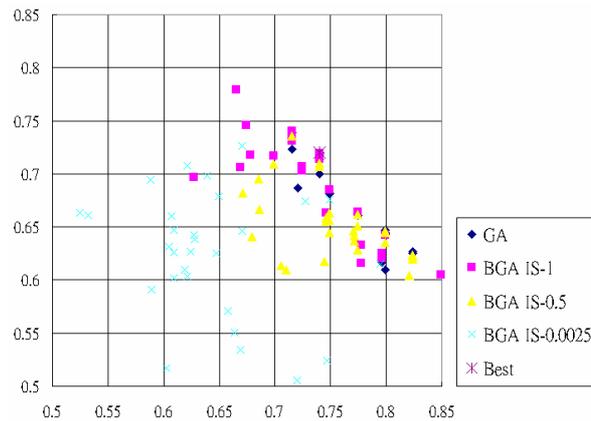


Figure 12. BGA simulations

The results in Table 3 show that BGA performs better when information is shared via the TAMON protocol. In the last case, where the degree of information sharing equals to 0.0025, only one offer was proposed in a turn (same as traditional negotiation model), and the ratio of average negotiation results drops dramatically. However, it is also found that by extending the TAMON game period, the results can be improved (see Figure 13, X-axis represents the degree of information sharing, and Y-axis the resulting utility product).

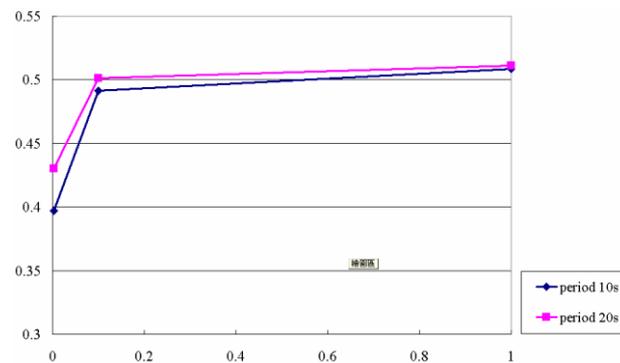


Figure 13. Effects of negotiation period

## 6. Conclusion and Future Work

We proposed the TAMON negotiation model and the BGA algorithm in this paper. The TAMON model defines a micro two-player negotiation game without time constraints, and allows more information to be exchanged in the negotiation game. The exclusion of time constraints is important for simplifying a TAMON game, since most search algorithms are not of real-time, and the search space tends to be static during the searching. It also permits a more complex search process to be conducted in a TAMON game, with a constraint that the process should be terminated after a period of time. By allowing more information to be disclosed in a tagged multi-offer format, the TAMON model incorporates the information sharing behavior into the negotiation model. We can say that the TAMON model provides a dimension for joint problem solving possibilities, yet it is still in the context of a non-cooperative game.

The BGA proposed in this paper utilizes the implicit parallelism of GA to search the solutions in a TAMON game. The elegance of the BGA is that it perfectly fits in the TAMON game since the population to be proposed is meaningfully transformed into the tagged multi-offer format, and with the degree of information sharing being taken into consideration. The algorithm is immune to the fixed-strategy limitation and the fixed-pie bias, and it is computationally tractable. It should be noted that it is not required that both players use the same algorithm in the negotiation. However, since the BGA can explore multiple strategies simultaneously, we are investigating that given the limitation of computational tractability, whether the BGA-like algorithm will be the only rational choice in a TAMON game.

We are developing a theory to measure the information disclosed in the tagged multi-offer protocol and to determine the precise effects caused by the information sharing in a multi-issue negotiation. A theory for guiding the choosing of BGA parameters, including the population size, the crossover rate and the mutation rate will also be addressed in the future work.

## References

- [1] Bazerman, M.H. and Carroll, J.S. "Negotiator cognition," *Research in Organizational Behavior* (9), B.M. Staw and L.L. Cummings (eds.), Greenwich, CT: JAI Press, 1987.
- [2] Chavez, A. and Maes, P. "Kasbah: An agent marketplace for buying and selling goods," *1st Intl Conf on Practical Appli. of Intelligent Agents Technology*, 1996.
- [3] Faratin, P., Sierra, C. and Jennings, N.R. "Negotiation decision functions for autonomous agents," *International Journal of Robotics and Autonomous Systems*, 1998, (24:3-4), 159-182.
- [4] Faratin, P., Sierra, C. and Jennings, N.R. "Using similarity criteria to make trade-offs in automated negotiations," *Artificial Intelligence and Int. Journal of Autonomous Agents and Multi-Agent Systems*, 2003. (to appear, downloadable at <http://www.ecs.soton.ac.uk/~nrj/download-files/aij03-faratin.pdf>)
- [5] Foroughi, A. "Minimizing negotiation process losses with computerized negotiation support systems," *The Journal of Applied Business Research*, 1998, (14:4), 15-26.
- [6] Goh, K.Y., Teo, H.H., Wu, H. and Wei, K.K. "Computer-supported negotiations: an experimental study of bargaining in electronic commerce," in *Proceedings of the 21st Annual International Conference on Information Systems*, Brisbane, Australia, 2000, 104-116.
- [7] Goldberg, D.E. *Genetic algorithms in search, optimization, and machine learning*, Addison-Wesley, 1989.
- [8] Holland, J.H. *Adaptation in natural and artificial systems*, The MIT Press, 1992.
- [9] Hordijk, W. and Manderick, B. "The usefulness of recombination," In F. Moran, A. Moreno, J.J. Merelo, and P. Chacon (eds.), *Advances in Artificial Life: Proceedings of the Third European Conference on Artificial Life*, Springer-Verlag, 1995, 908-919.
- [10] Lomuscio, M.W. and Jennings, N.R. A classification scheme for negotiation in electronic commerce. In F. Dignum and C. Sierra, editors, *Agent-Mediated Electronic Commerce: A European Agentlink Perspective*, Springer-Verlag, 2001.
- [11] Maes, R.P. and Moukas, A.G. "Agents that buy and sell," *Communications of the ACM*, 1999, (42:3), 81-91.
- [12] Matwin, S., Szapiro, T., and Haigh, K. "Genetic algorithms approach to a negotiation support system," *IEEE Transactions on Systems, Man, and Cybernetics*, 1991, (21:1), 102-114.
- [13] Oliver, J.R. "A machine learning approach to automated negotiation and prospects for electronic commerce," *Journal of Management Information Systems*, 1997, (13:3), 83-112.
- [14] Raiffa, H. *The Art and Science of Negotiation*, Harvard University Press, Cambridge, USA, 1982.
- [15] Rubinstein, A. "Perfect equilibrium in a bargaining model," *Econometrica*, 1982, (50:1), 155-162.
- [16] Sandholm, T. "Agents in electronic commerce: component technologies for automated negotiation and coalition formation," *Autonomous Agents and Multi-Agent Systems*, 2000, (3:1), 73-96.
- [17] Sycara, K.P. "Negotiation planning: an AI approach," *European Journal of Operational Research*, 1990, (46), 216-234.
- [18] Thompson, L.L. and Hastie, R. "Social perception in negotiation," *Organizational Behavior and Human Decision Processes*, 1990, (47), 98-123.

# E-Learning: A Study of Issues and Perspectives

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## Abstract

This study examines some of the issues and perspectives associated with development and delivery of an undergraduate business degree incorporating e-learning. The investigation was undertaken in an Australian University and incorporates the opinions and viewpoints of staff and students - both local and offshore. E-learning is a complex, and often poorly structured knowledge area, with many different issues, influences and agendas. For this reason Soft Systems Methodology (SSM) has been used to develop a model for analysis and for comparison of the issues with the literature.

## 1. Introduction

Most universities in Australia now offer online courses, and face challenges that include limited budgets, the availability of appropriate content, provision of student support, and the often rigid traditions in education and learning [16]. This is also reported by Cameron [2] who observes that Australian universities are making major investments in information and communication technology (ICT) upgrades. Flexible self-service, both in university administration and course delivery, is becoming increasingly important.

Consider the question posed by Cameron [2, p.42]: "...what has spurred so many Australian universities to invest so heavily in ICT upgrades, particularly in online learning and self-service?" The suggested answer is that this is a response to the increased competition for students and funds. The universities hope that e-learning technology will help them diversify their commercial interests, and enhance the variety and degree of online offerings to students and staff. However, Lee [12] expresses concern that e-learning will remain in the realm of rhetoric as long as it is no more than provision of lecture materials on the Web, with the Internet being used little more than a delivery medium.

This study, conducted in an Australian University, seeks to better understand the issues and challenges associated with e-learning. It adopts a systems approach

that incorporates the opinions, concerns, and viewpoints of the staff and students who represent the major stakeholders in applying this technology to teaching and learning.

## 2. A Systems Approach

E-learning projects typically exist in complex and poorly structured socio-technological environments, with many different issues, influences and agendas. Furthermore, Wilson [24] observes that a number of cultural discontinuities impact upon online learning effectiveness. In particular, the worldview of the learner is a key factor in better understanding how users navigate the teaching and learning interface. Therefore this study utilizes a systems approach that is suited for the analysis of complex situations where the worldview and the transformation at the learner interface is important.

Soft systems thinking seeks to explore the messy problematic situations that arise in human activity. It strives to learn from the different perceptions that exist in the minds of the different people involved in the situation [1]. This interpretive approach is strongly influenced by Vickers' [23, pp.59,176] description of the importance of appreciative systems in dealing with human complexity. Checkland [3], and Checkland and Scholes [4] have transformed these ideas from systems theory into a practical methodology that is called Soft Systems Methodology (SSM). Checkland [3, p.258] applies a core paradigm of learning to problems of complexity with poor structure, and so SSM attempts to understand the fuzzy world of complex organizations.

SSM, in its idealized form, is described as a logical sequence of seven steps [3, pp.162-183]. These are:

- Stages 1 and 2 - Expression of the problem
- Stage 3 - Selection of a Root Definition
- Stage 4 - Model Building - the Conceptual Model.
- Stage 5 - Comparison
- Stage 6 and 7 - Recommendations for Change, and Taking Action.

This is illustrated in Figure 1.

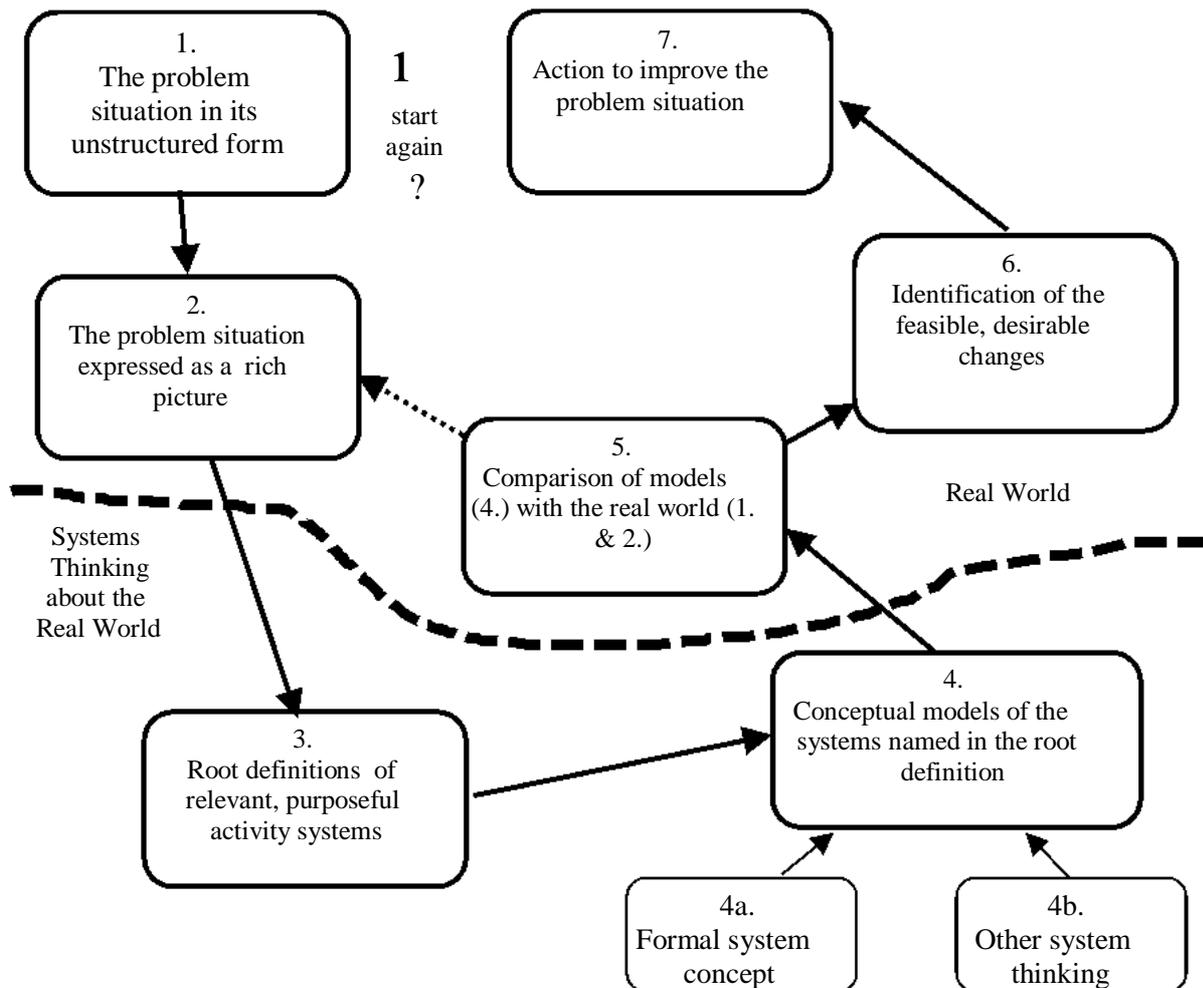


Figure 1 Summary of SSM as a seven-stage process  
 (Adapted from Checkland, [3, p.163] and Checkland & Scholes, [4, p.28])

It is most important to note that the sequence is not imposed upon the practitioner; a study can commence at any stage, with iteration and backtracking as essential components. SSM encourages investigators to view organizations from a cultural perspective.

### 3. Building a Model of E-Learning

This analysis will be conducted following the steps shown in Figure 1. This will be done rigorously for Step 1 through to Step 4, which produces a conceptual model of feasible and desirable activity. The final three steps of the methodology will be incorporated into the discussion that follows (Part 4 – Analysis of Issues).

#### 3.1 Step 1 - The Problem Situation

This step of the analysis is an unstructured narrative about the situation, and what makes it problematic. The narrative begins:

Within the Faculty of Business there is strong pressure from both the University Chancellery and the Dean's Office to undergo course renewal of all courses. In practical terms this has been translated to mean that all courses are to be repackaged and delivered online over the Internet.

Interested academic staff members have been recruited as Technical Skills Mentors to assist other staff members in this task. Academics are instructed to 'go online' before the next scheduled delivery of their course. This allows most academics between six weeks and seven months to undertake this task for one or more courses, depending on how many courses are available.

Academics are offered a choice of approved software tools to use, including Dreamweaver, WebObjects and Frontpage. Adoption of a particular tool is often either a personal preference, or the recommendation of the Technical Skills Mentor. There is no attempt to standardize to a specific tool with any study program.

Table 1: Feedback from students - delivery of courses online

Melbourne Students (15)		Hong Kong Students (32)	
Best	Worst	Best	Worst
Flexibility in when a student can study - time (9)	Less interaction with class members and lecturer (8)	Flexibility in when a student can study - time (21)	Cannot get a face-to-face answer from a lecturer (16)
Flexibility in where a student can study - place (5)	Dependence on IT that often has problems and can be slow (5)	Flexibility in where a student can study - place (19)	Less interaction with class members, teams and the lecturer (16)
Can get access to notes whenever they are needed without travelling to the uni (4)	Online communication and discussion is slow and limited compared to face-to-face interaction (4)	A less expensive way to study (9)	Need access to an up-to-date computer, the Internet and have good knowledge of computers (8)
Online forum and chat provide a good way of discussing issues with a wider variety of people (3)	Delays in getting email feedback from lecturers (4)	Access to a bigger choice of courses and courses in different countries (7)	Dependence on IT that often has problems and can be slow (7)
Can avoid using slow and unreliable university computer laboratories (1)	Reference material listed online may not be available (1)	Online forum and chat provide a good way of discussing issues with a wider variety of people (5)	Requires discipline (7)
Access to a bigger choice of courses and programs (1)	Prefer to read on paper to using a screen (2)	Attractive interface - prefer to read material off a computer (4)	Prefer to read on paper to using a screen. May be harmful to eyes (6)
		Environmentally friendly way to study (3)	Need more time to read and understand the online material (2)
		Fast way to learn (1)	Boring (2)
			Delays in getting email feedback from lecturers (1)

From the start of Semester 2 (July 2000) courses taught in the faculty of Business began to become available online. However, not all courses have a web-presence, and there are different styles of presentation and web page design. The approach ranges from single web page sites consisting of a table of hyperlinks to course resources (usually PowerPoint slides and Word documents), to complex hierarchies of pages that provide information pages and links covering all parts of a course.

The response by students is enthusiastic, but varied and often conditional. Table 1 is a summary of feedback from two groups of the investigator's students, studying the same courses in Melbourne and in Hong Kong. These are the responses to the question - what are the best and worst features of having material provided online?

In June 2001 the University entered into an alliance with an offshore education broker. The immediate effect was that a number of popular business degree programs were targeted to be offered completely online as 'international programs'. The Dean has announced that a 'flag-ship' degree - Bachelor of Commerce (known as the Generic Degree) - is to commence next semester. The main market identified for the online Generic Degree is China. Content for courses to be offered in the Generic

Degree must be finalized and available by Monday 3 December, 2001. Furthermore, the Generic Degree is standardized to Dreamweaver, and all materials must be compatible with this tool. Many academic staff are dismayed by the pressure placed upon them. They are concerned not only with the workload, but they also fear losing ownership of the material, and are concerned that assessment will be 'dumbed-down' to fit into the online environment. This concludes the narrative and Step 1.

### 3.2 Step 2 - The Rich Picture

A key goal of this stage is to achieve a structured representation of the problematic situation in as neutral a way as possible. This is achieved by building a Rich Picture. This is a pictorial representation of the structures, processes, situation, relationships and issues. It is not, however, a system diagram!

Figure 2 is a Rich Picture of the elearning - Generic Degree situation. It aims to show the elements of a slow-to-change structure, and the elements of a constantly changing process within the situation described in the above narrative.

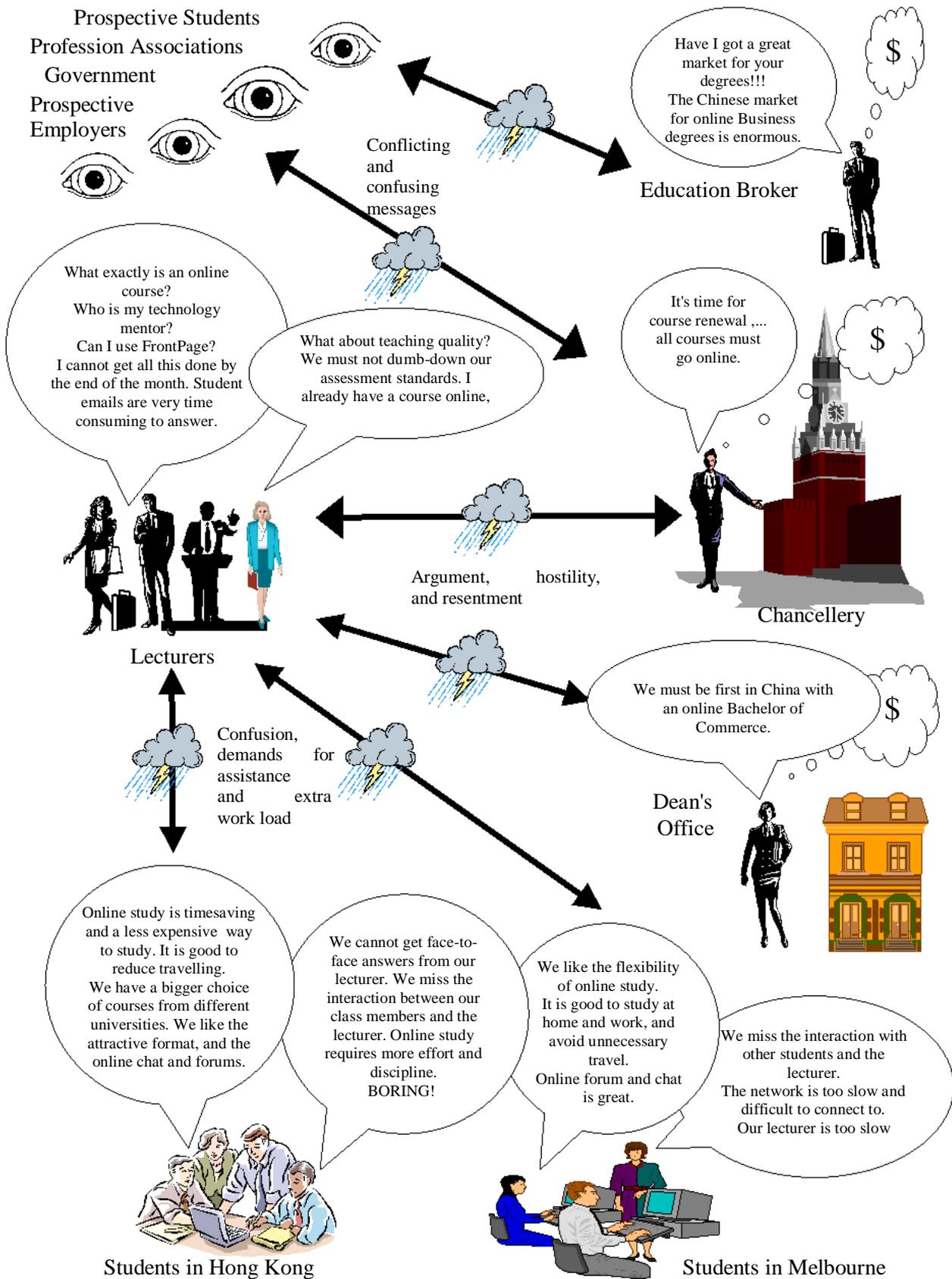


Figure 2 Rich Picture of e-Learning - Generic Degree

### 3.3 Steps 3 and 4 - The Root Definition and Model

Before creating a model, Step 3 seeks to define an appropriate system to improve the situation in a way that is desirable and feasible. This is achieved by constructing a root definition. The mnemonic CATWOE is used to check that all the components are in the root definition.

- C Clients, customers (or victims) of the system.
- A Actors who carry out activity in the system.
- T Transformation - being the conversion of the inputs into a changed form.
- W Weltanschauung (or constraining worldview) that makes this definition meaningful.
- O Owner, the person with the power to start or stop the system.
- E Environment - world surrounding the system, that provides the external constraints.

It is important to appreciate that the CATWOE is only a component checklist. The appropriateness of a root definition can only be evaluated through the dialectic process of examination, debate and argument and modification.

It is important also to examine the conceptual model derived from the root definition. Therefore, Steps 3 and 4 are presented together in this study (Figure 3). Based on the root definition, a model is drawn of the theoretical or conceptual construction. This model will show the minimum necessary activities that exist in the system to achieve the transformation described in the root definition.

The conceptual model should only include activities that can be directly carried out. There should never be the expectation that a root definition or conceptual model cannot be improved upon.

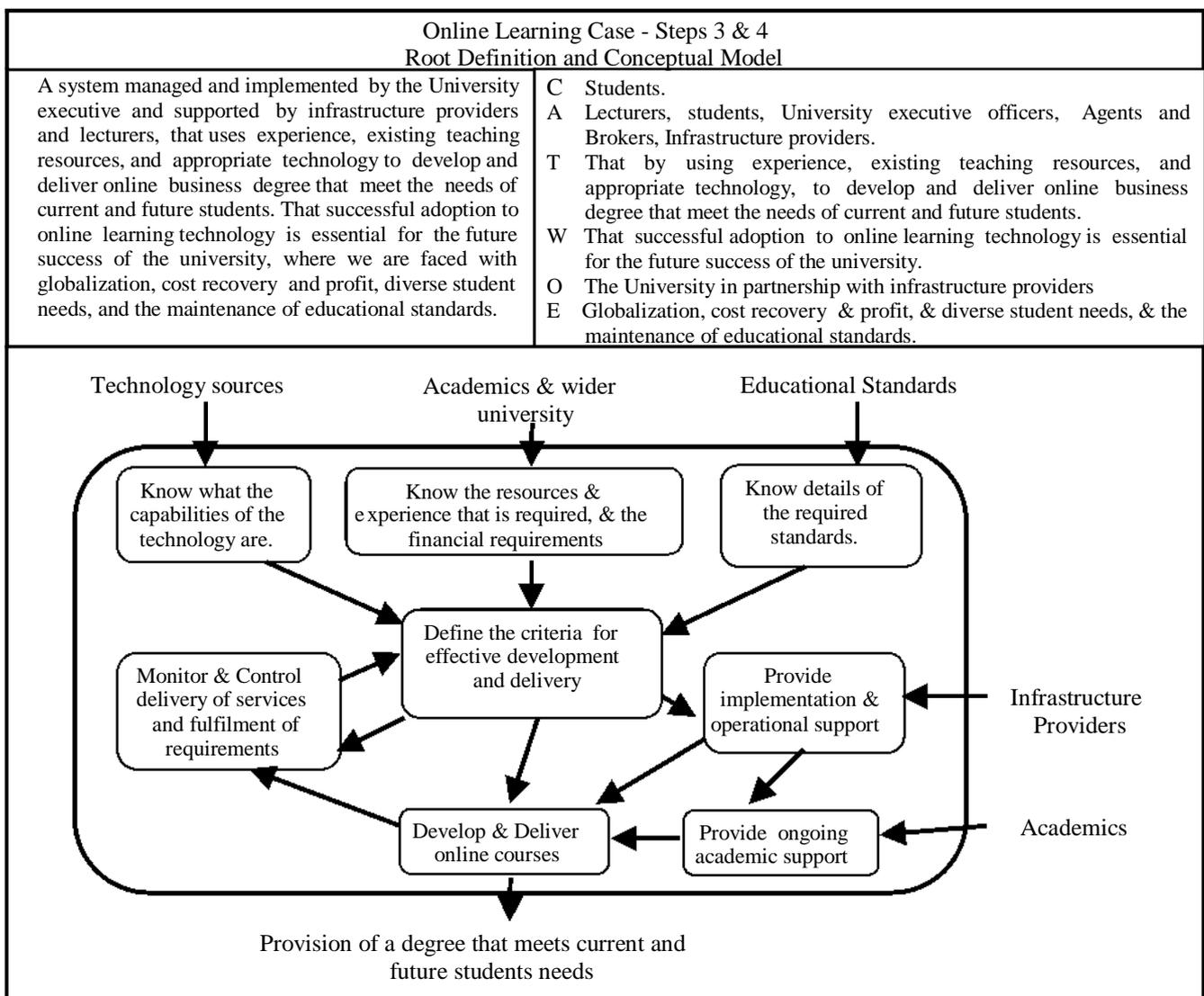


Figure 3 Root Definition and Conceptual Model

## 4. Analysis of Issues

The conceptual model illustrated in Figure 3 provides a set of activities that can be used to learn more about the situation, and in this case study it provides a framework for undertaking an issues analysis.

### 4.1 Activity 1 - Know what the capabilities of the technology are.

The first activity is concerned with acquiring knowledge of technology capabilities. As the case study shows with reference to web page creation tools, there are always choices with technology, and better choices can be made if relevant knowledge is acquired. Torrisi-Steele and Davis [22] comment on the importance of selecting web-authoring technology. In particular, skill development in web authoring and online course design can be both demanding and difficult. However, these skills are essential to realize the full potential of e-learning.

### 4.2 Activity 2 - Know the resources and experience that is required, and the financial requirements

The second knowledge activity appears to be problematic in the case study as it obviously requires collaboration between the academics - with some resources and the experience - and the university executive, who have more resources and the knowledge of the financial requirements. However, this knowledge must be integrated into the total process. As Galagan [6] observes, universities need to ensure that online learning is part of a training strategy that links to business goals.

Where there is a cross-cultural component to an e-learning initiative, Sakurai [15] and Gunawardena, Nolla, Wilson, Lopez-Islas, Ramirez-Angel and Megchu-Alpizar [10] emphasizes the need for a major commitment in time and resources. In particular, Goodfellow, Lea, Gonzalez and Mason [9] argue the need to study cross-cultural interactions within the e-learning environment with attention to the implications for learning and teaching.

### 4.3 Activity 3 - Know details of the required standards

The third knowledge activity moves the focus beyond the university into the wider community. In many cases appropriate standards have not been formalized for e-learning. A particular area of concern of many lecturers is the "dumbing-down" of assessment tasks and the preference for "soft-assessment" that occurs in particular circumstances. These issues are also of concern to the wider community, and especially prospective employers. Therefore appropriate standard should be developed in consultation with key stakeholders. Youngblood, Trede and Di Corpo [25] recommend that rules of participation should be formalized as the framework for monitoring

participation. However, this will become more complex with international program delivery and globalization.

### 4.4 Activity 4 - Define the criteria for effective development and delivery

Schelin and Smarte [18] warn that developers must assess the needs of the student population and clearly target skills and knowledge gaps before developing online courses. A set of guidelines to assist in this activity, in the form of five questions, is provided by Sheely, Veness, and Rankine [19, p.80]:

How do we do it? How do we use these packages most effectively?

How do we integrate them into existing systems?

How do we support academics to make most effective use of the tools that are available?

A particular concern in this activity is setting the criteria for development of interactive online learning. This is a major anxiety of many of the students in the case study. Sims [20] also identifies interactivity as one of the major challenges faced by designers of e-learning resources. In particular it is observed that complexity of learner-computer interactivity has yet to be fully unraveled. Swan [21] addresses this issue of design and identifies three important factors that influence student satisfaction:

1. The clarity of the design of the online course.
2. The ability to interact with instructors.
3. The support of active discussion among the students.

### 4.5 Activity 5 - Provide implementation and operational support

This activity will be directly driven by the choices made in the definition and selection of criteria for development and delivery of the system. As seen in the case study, this activity is important in terms of student satisfaction, especially with regard to the speed and reliability of Internet access. Sakurai [15] states the need to develop a network infrastructure capable of supporting rich media content, and warns that without this an online program will be just like reading text.

### 4.6 Activity 6 - Provide ongoing academic support

Within universities that are developing e-learning for the first time, the critical success factor is internal marketing. Promotion of a new way of teaching is essential, with Roberts [14, p.106] observing that "takes a lot of effort to get the old guys who are now in leadership roles to support these efforts."

However, there are attractive aspects to this activity. E-learning has the potential to bring together the best teachers, with the best learning plans and enthusiasm for learning, to the students who want it, anywhere in the world [7]. This is particularly attractive to organizations who desire flexibility in the delivery of teaching programs [26]. Schelin and Smarte [18] observe that

while you cannot compel academics to participate in e-learning, the success of these programs depends upon a large commitment from teaching staff.

#### 4.7 Activity 7 - Develop and deliver online courses

This is the activity that delivers the outcome - provision of a degree program that meets current and future students needs. This is the "operational core" upon which all the other activities focus and provide inputs. This activity is a system in its own right, and can be modelled in greater detail.

#### 4.8 Activity 8 - Monitor and control delivery of services and fulfilment of requirements

This final activity provides the monitoring and control loop that observes the performance of the system, and provides feedback to control via the criteria setting activity as necessary. This is consistent with the need identified by Herberger [11] to define and redefine the educational product outcome of an e-learning system. More specifically Leonard and Guha [13] and Chen, Lou and Luo [5] observe that the motivation for using e-learning is the promise of improved competence in completing course work. This is an example of an important performance measure to be monitored.

### 5. Conclusion

In this study a systems model has been developed to provide a framework for examination of the issues and perspectives of the stakeholders associated with this investigation of e-learning. Overall, the attitude of the students is generally positive, moderated with a concern for opportunities to interact with other students and academic staff. This is consistent with the findings of Youngblood et al. [25] and Gallini and Barron [8], that students need specific guidelines and structures for interacting over the Internet. Without these formal frameworks for collaboration, students may fail to become engaged in coherent group work that is based upon meaningful interactions.

In support of the positive responses, Sanders and Morrison-Shetlar [17] report that students have a highly positive attitude towards the addition of web-enhanced components to traditional course material. This, together with the case study, suggests that e-learning is successful when integrated into other learning delivery modes. However, more research is required in this area, especially from the viewpoints and perceptions of staff involved in the delivery of innovative "multi-mode" learning programs.

### References

[1] Andrews, C.L. "Restoring legitimacy to the systems approach". *IEEE Technology and Society*, 2000, 19 (4), 38-44.  
[2] Cameron, F. "Beyond the Blackboard". *MIS Australia*, August 2002, 36-38, 40, 42.

[3] Checkland, P.B. *Systems Thinking, Systems Practice*. John Wiley & Sons, 1981.  
[4] Checkland, P.B. & Scholes, J. *Soft Systems Methodology in Action*. John Wiley & Sons, 1990.  
[5] Chen, Y., Lou, H. & Luo, W. "Distance Learning Technology Adoption: A motivational perspective". *Journal of Computer Information Systems*, 2002, 42(2), 38-43.  
[6] Galagan, P.A. "Getting started with E-learning". *Training & Development*, 2000, 54(4), 62-64.  
[7] Galagan, P.A. "Mission E-possible". *Training & Development*, 2001, 55(2), 46-56.  
[8] Gallini, J.K. & Barron, D. "Participants' perceptions of Web-infused environments: A survey of teaching beliefs, learning approaches, and communication". *Journal of Research on Computing in Education*, 2001, 34(2), 139-156.  
[9] Goodfellow, R., Lea, M., Gonzalez F. & Mason R. "Opportunity and e-quality: Intercultural and linguistic issues in global online learning". *Distance Education*, 2001, 22(1), 65-84.  
[10] Gunawardena, C.N., Nolla, A.C., Wilson, P.L., Lopez-Islas, J.R., Ramirez-Angel N. & Megchu-Alpizar R.M. "A cross cultural study". *Distance Education*, 2001, 33(3), 85-121.  
[11] Herberger, R.A. "The Future of E-learning". *Selections*, 2001, 1(1), 28.  
[12] Lee, G.S. "The rhetoric and the reality of e-learning". *Computimes Malaysia*, Aug 27, 2001, 7.  
[13] Leonard, J. & Guha, S. "Education at the Crossroads: Online teaching and students' perspectives on distance learning". *Journal of Research on Technology in Education*, 2001, 34(1) 51-57.  
[14] Roberts, B. "E-learning: new twist on CBT". *HR Magazine*, 2001, 46(4), 99, 101, 103-104, 106.  
[15] Sakurai, J.M. "Foreign Faux Pas: Culture - the final barrier to going global". *E-Learning*, 2002, 3(7), 26-30.  
[16] Samuels, D. "On learning online". *Risk Management*, 2001, 48(2), 8-9.  
[17] Sanders, D.W. & Morrison-Shetlar, A.I. "Student attitudes towards Web-enhanced instruction in an introductory biology course". *Journal of Research on Computing in Education*, 2001, 33(3), 251-263.  
[18] Schelin, E. & Smarte, G. "Recognizing the Champions". *E-Learning*, 2002, 3(4), 12-19.  
[19] Sheely, S., Veness, D. & Rankine, L. "Building the Web Interactive Study Environment: mainstreaming online teaching and learning at the University of Western Sydney". *Australian Journal of Educational Technology*, 2001, 17(1), 80-95. [Electronic Journal]. URL <http://cleo.murdoch.edu.au/ajet/ajet17/sheely.html>  
[20] Sims, R. "Interactivity on stage: strategies for learner-designer communication". *Australian Journal of Educational Technology*, 1999, 15(3), 257-272. [Electronic Journal]. URL <http://cleo.murdoch.edu.au/ajet/ajet15/sims.html>  
[21] Swan, K. "Virtual interaction: Design factors affecting student satisfaction and perceived learning in asynchronous online courses". *Distance Education*, 2001, 22(2), 306-331.  
[22] Torrisi-Steele, G. & Davis, G. "A website for my subject": The experiences of some academics' engagement with educational designers in a team based approach to developing online learning materials". *Australian Journal of Educational Technology*, 2000, 16(3), 283-301, [Electronic Journal]. URL <http://cleo.murdoch.edu.au/ajet/ajet16/torrisi-steele.html>

- [23] Vickers, G. *Value Systems and Social Process*. Penguin Books, 1968.
- [24] Wilson, M.S. "Cultural considerations in online instruction and learning". *Distance Education*, 2001, 22(1), 52-64.
- [25] Youngblood, P., Trede, F. & Di Corpo, S. "Facilitating online learning: A descriptive study". *Distance Education*, 2001, 22(2), 264-284.
- [26] Zurawski, L. "Train in your own time". *Control engineering*, 2000, 47(3), 66.

# How to Setup a Successful E-Learning System for E-Business<sup>†</sup>

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## Abstract

E-Learning is burgeoning now, it develops a new way to enhance corporate competence effectiveness. Why should corporations investigate in an e-Learning system for e-Business? Because it provides a real-time and supporting learning environment for e-Business. In addition to be a profitable learning system, it can also be connected to ERP and CRM systems to generate an integrated solution for e-Business.

It lists the differences and barriers between traditional training and e-Learning. Although there are barriers, corporations still get their own reasons for setting it up. It lists the learning needs from different stakeholders. It introduces an example of LMS-LCMS integration in a learning ecosystem from IDC, and is followed by procedures to be taken to construct it.

Strategies should be correctly set and e-Learning project plans should be well defined and implemented. Success and challenge factors are also discussed to advise project leaders motivation and shortcoming elements of an e-Learning system. By calculating the e-Learning ROI, corporations can adjust their e-Learning strategies in order to keep a flexible management.

**Keywords: e-Learning, LCMS, LMS, ROI**

## 1. Introduction<sup>†</sup>

People are used to learn in the classrooms, they sat down by one another and the instructors were in front of them. They read from the blackboards and wrote down what the instructors had told and written to them. But today, the learning revolution has changed the above situations. Instructors and learners are connected via the Internet. That is so called e-Learning. In the autumn of the year 2000, the HR World is being battered by a storm. It has had many different names over the years, but today it is mainly known as e-Learning. E-Learning will not replace traditional classroom training. Frankly speaking, they are complements each of the other.

Are there relationships between traditional training and e-Learning? In fact, they will help each other with their own specific advantages. To have a more clear description,

for example, traditional training is taken place at a specific place and a scheduled time, while e-Learning happens at any place and anytime. Moreover, there are many differences between them. Corporations can choose the training approaches that can best fulfill their needs. If their learning environments are not ready for e-Learning only training. they can also choose a blended learning which combine traditional training and e-Learning approaches. This paper compares six different items between traditional training and e-Learning. E-Learning system shows clear that it is suitable in knowledge economic era via the Internet. They are shown in table 1.

**Table 1 : Comparisons between traditional training and e-Learning**

Item	Traditional training	E-Learning
Function	⊙ Training for new skills and knowledge	⊙ Training for new skills and knowledge ⊙ Strategic business tool
Training place	⊙ Physical classroom ⊙ Limited scale ⊙ Fixed location	⊙ Virtual classroom ⊙ Global wide scale ⊙ Any place
Content	⊙ PowerPoint slides ⊙ Textbooks	⊙ Animation ⊙ Simulation ⊙ Online resources
Learning schedule & time	⊙ Instructors control the topics and schedules ⊙ Instructor-Led ⊙ Fixed time	⊙ Learners control the topics and schedules ⊙ Self-Paced ⊙ Any time (24 x 7)
Problem solving	⊙ Ask instructors for help ⊙ More interactive	⊙ Ask online instructors for help (synchronous) ⊙ Message boards, chatrooms, and e-mail (asynchronous)
Evaluation	⊙ Level I to Level IV evaluations	⊙ Level I to Level V (ROI) evaluations

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First, their functions are different. Although they are all trainings for new skills and knowledge, more than that, e-Learning is also a strategic business tool which can be integrated into an e-Business system and be used to achieve the business objectives. Their training places are also different - from physical to virtual classroom, limited to global wide scale, and fixed location to any place. Powerpoint slides and textbooks will be replaced by animations, simulations, online resources, and so forth.

Instructors no longer have to assign learning topics or schedules. Instead, learners have to be more active to their learning topics or schedules. They should decide what and when they want to learn. They can access online training courses 24 hours a day, 7 days a week. When learners get any questions during the online training courses, they will use different ways to communicate with instructors. They must “talk” to e-Learning instructors via the Internet by using their computers. Message boards, chatrooms, and e-mail will also help them to find someone to solve problems.

Finally, when comparing their ways of measuring training results, traditional training can only do Level I to Level IV evaluations, but e-Learning can do Level I to Level V – Return on Investment (ROI) evaluations. They are discussed in more details in the last section of this paper.

## 2. Points of Research

An e-Learning system will be a strategic business tool to increase business speed, flexibility, retention, and employee satisfaction. As projected by IDC, the market for e-Learning services, content and technology will be over \$11 billion, growing at a nearly 100% compound annual growth rate by 2003 [4].

Although, e-Learning is now getting more popular, but there are still some critical points that corporations still feel confused. This research intends to give some general ideas on how to setup a successful e-Learning system for e-Business.

It first introduces the e-Learning marketplace - four barriers and SWOT analysis are discussed. With the above two analysis results, corporations will get their own e-Learning readiness situations in their minds. Different stakeholders will have different reasons for setting up the system. One environment of e-Learning system from IDC is also introduced.

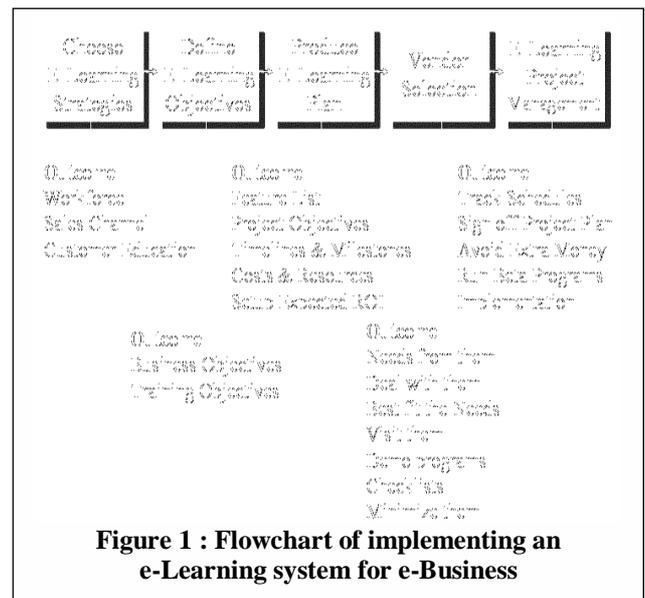
Steps that are needed to implement an e-Learning system for e-Business are proposed. They will provide general procedures which will be practical. They include strategies, objectives, plan, vendor selection, and project management. Success and challenge factors will suggest motivation and challenging powers towards the system. Corporations can improve their e-Learning system day after day by applying the factors. Finally, five ways to measure the performance of e-Learning system – level I to level V, are suggested. The paper intends to provide methodologies to setup a successful e-Learning system for e-Business by all the topics discussed.

## 3. Approaches

Related e-Learning papers are reviewed together to give general ideas and descriptions of the paper. “Analysis of e-Learning marketplace” introduces the e-Learning marketplace – it presents four barriers and SWOT to describe the e-Learning environments that corporations will be facing. “Corporate reasons for setting up an e-Learning system for e-Business” discusses the feelings of different stakeholders inside corporations about an e-Learning system despite the barriers. One e-Learning system model from IDC depicts related components – LMS, LCMS, delivery systems, and back end systems integration.

According to DigitalThink [4] and this research, there are five steps proposed as the approaches to setup an e-Learning system. Each of them is related to one another. Please refer to figure 1 for the flowchart.

“Choose e-Learning strategies” will need to know what corporations want from the e-Learning system first. According to DigitalThink researches [4], there are three categories of strategies : “workforce transformation”, “sales channel optimization”, and “customer education” strategies. “Workforce transformation strategy” will help to increase productivities and cause higher retention of employees. “Sales channel optimization strategy” will shorten time and knowledge to market, fasten delivery speed, and increase time spent on selling. “Customer education strategy” focuses on how to give customers related education and satisfactory services. “Define e-Learning objectives” will describe what corporations really want to get. There are business and training objectives. Business objectives focus on how to improve effectiveness of workforce transformation, sales channel optimization, and customer education. Training objectives are concerned with learning plans, ability to access training resources, integrations of coursewares, and so forth.



**Figure 1 : Flowchart of implementing an e-Learning system for e-Business**

“Produce e-Learning plan” provides steps to produce an e-Learning plan. It lists all tasks that must be undertaken, together with related stakeholders involved. Every key milestone is well defined and scheduled. LMS / LCMS, LAN installation, coursewares offerings and authoring are good examples of key milestones. Also, resources and costs needed have to be well arranged and calculated. Please provide predefined ROI before the performances of e-Learning system is evaluated. It will become the criteria for measuring success of e-Learning system.

“Vendor selection” helps to find suitable vendors to be corporate with. It lists seven steps needed to be taken. By following them, corporations will choose correct vendors and solutions that are best to fulfill their needs.

“E-Learning project management” suggests ways to manage an e-Learning project. It tracks project schedules, assures signing off the project plan, avoids spending extra money, runs beta programs, and implements a successful e-Learning system.

Finally, “success factors” suggests the motivation power to make the e-Learning system grow up and run smoothly. “Challenge factors” suggests the challenging power to threaten the normal behaviors of an e-Learning system. “Evaluation and ROI” lists the ways to measure the e-Learning performance using four levels (Level I ~ IV) developed by Donald Kirkpatrick and Level V enhanced by Jack Phillips. Level V will calculate corporate return on investment (ROI) [7].

#### 4. Analysis of E-Learning Marketplace

Although the market is still growing, there are many barriers needed to be overcome when planning to setup an e-Learning system for e-Business [10]. In this paper, four barriers are proposed to explain what should be conquered by most corporations. Figure 2 below depicts the four general barriers to e-Learning.

The first barrier is “budgetary considerations”. It will consider e-Learning budgets. It is expensive to setup an e-Learning system for e-Business. There are very few successful e-Learning implementation stories, so they will not spend a lot of money on it now. In fact, corporations will cut e-Learning budgets very often.

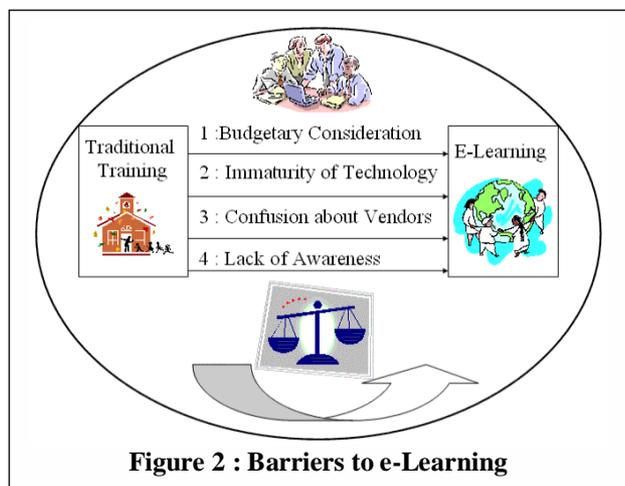


Figure 2 : Barriers to e-Learning

The second barrier is “immaturity of e-Learning technology”. The technologies are still young and new. The average life cycles of them are about two years which are too short to motivate corporations to adopt them. If corporations adopt immature e-Learning technologies, they will soon regret.

The third barrier is “confusion about the vendors”. Because the e-Learning markets are still fragmented and lacking of integrated solutions, so most vendors will have to develop the contents, technologies and services on their own. Few vendors finish developing complete solutions, they are still having experiments and researches.

The fourth barrier is “lack of awareness”. People do not know very well in which way e-Learning will really change their training models. They already get used to traditional trainings and do not feel like to accept new ways to be trained. It will take time for learners to establish new styles of habits before it gets popular.

SWOT (Strengths-Weaknesses-Opportunities-Threats) analysis of e-Learning will help corporations to know the characteristics of their e-Learning system when being applied. Figure 3 shows SWOT analysis of e-Learning. It includes the descriptive functions of SWOT to help corporations transforming from traditional trainings to e-Learning.

The strengths of e-Learning will be its advantages to get supports from top managements. It shows that e-Learning will overcome time and place barriers that traditional trainings are used to have. Instead, learners can access it whenever and wherever they want. It will not need to pay traveling costs, so the costs will be lower.

The weaknesses of e-Learning are shortages to make people feel disappointed. Especially the technology to setup an e-Learning system is new. Not many people know it very well. Also, learners may not be used to this kind of learning. They cannot see each other. They can only use computers to talk to other learners and instructors. They may need some helps from experts even more.

The opportunities of e-Learning will provide some possible ways for corporations to adopt e-Learning as their new training approach. They are the chances to be succeed or fail. Although e-Learning may have weaknesses and threats, there are still opportunities which will attract

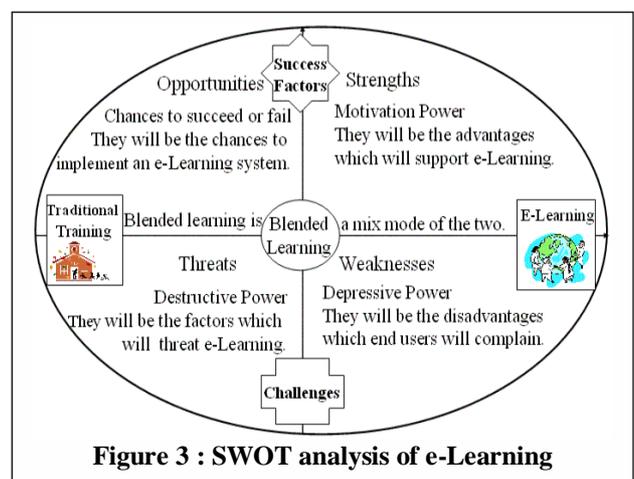


Figure 3 : SWOT analysis of e-Learning

corporations get involved with the implementation of e-Learning system. It will provide the best and quickest way to communicate with one another all over the world. It provides a new approach to reach news and knowledge of any desired place on the earth.

The threats of e-Learning will be destructive power to threaten e-Learning solutions. Since e-Learning is less interactive, learners may not have much interest on it for a long time. Technologies and requirements of e-Learning will also limit the development. If corporations know the threats of e-Learning in advance, they can be prepared to reduce the impacts.

### 5. Reasons for Setting up an E-Learning System for E-Business

Why do corporations want to setup an e-Learning system for e-Business despite the barriers ? Because it will provide an effective way for corporations to learn and gain knowledge easily. Besides, it will support a real-time, supporting, and profitable learning environment for e-Business. It will be integrated with ERP and CRM systems to give a total e-Business solution.

Why are there so many corporations interested in having an e-Learning system for e-Business right now ? Because the time has come. Traditional trainings can no longer cover all corporate trainings. Instead, e-Learning system will help to provide a more efficient way of delivering information and knowledge needed. Especially now many corporations adjust their paces to become learning organizations, what will most benefit them are knowledge and information. The ones who win will need to have good controls on their corporate intellectual capitals. In fact, the technology of e-Learning will support them successfully.

An e-Learning system will provide an online learning system to connect stakeholders via the Internet. Most of them will get what they want in a quicker time. They get different ideas of what an e-Learning system can help them with their daily works. Figure 4 below shows the relationships between different viewpoints towards an e-Learning system for e-Business.

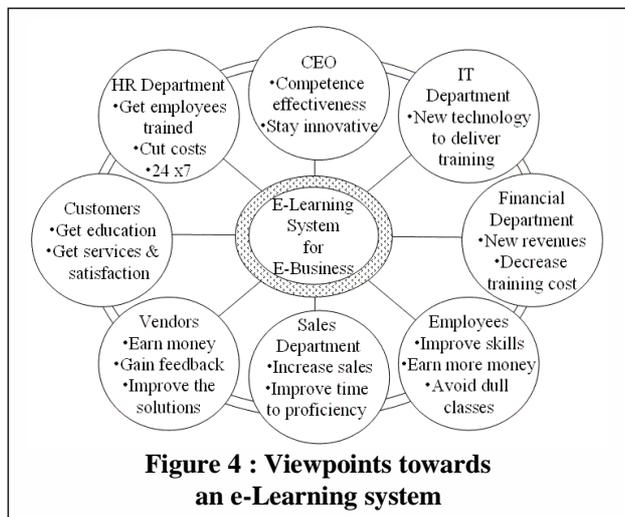


Figure 4 : Viewpoints towards an e-Learning system

CEO may view it as ways to increase competence effectiveness, reduce cycle time, and stay creative and innovative. They should have the courage to adopt an e-Learning system. Human resource departments may view it as ways to get employees trained, cut training costs, and a 24 x 7, on target training system. They should know very well that e-Learning system will improve training processes. IT departments may view it as a new kind of technology to deliver effective training courses. They should come out with the needs of e-Learning system infrastructure. Financial departments may view it as ways for a new revenue resource and decreasing training costs. Sales departments may view it as ways to increase sales, improve time to proficiency, and reduce turnover. They should provide what kinds of e-Learning strategies that will improve their selling processes. Employees may view it as ways to improve skills, earn more money, and avoid dull classes. They should learn how to use the e-Learning system. Finally, customers may view it as ways to get education, good services, and satisfaction. They will benefit from the e-Learning system and feedback to corporations.

Although, there are still some barriers between traditional trainings and e-Learning, the trends are now getting unstoppable. Clear understandings about the e-Learning system will give good profits if being used well. Since it will give different people what they want, why should there be any doubts for setting it up ? So, next step is to know the e-Learning system more, cross the barriers, and get started.

### 6. E-Learning System for E-Business

There are Learning Management Systems (LMS), Learning Content Management Systems (LCMS), content composition system, delivery system, and legacy system integration services which build up an e-Learning system for e-Business environment. Figure 5 depicts LMS-LCMS integration in a learning ecosystem from IDC [9].

The LMS is the operation system of an e-Learning system. It will manage registration, scheduling processes,

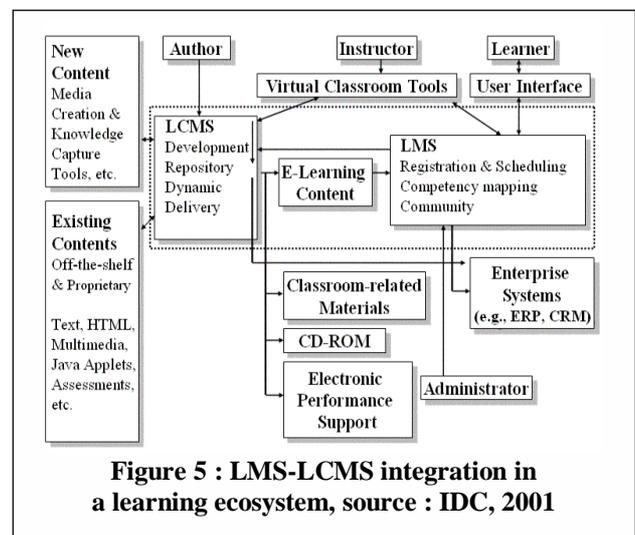


Figure 5 : LMS-LCMS integration in a learning ecosystem, source : IDC, 2001

and competency mapping community. Administer can track online, classroom-based learning events, and other training processes by using the LMS. Instructor can use virtual classroom tools to manage e-Learning courses, track learner progresses, record test scores, indicate course completions, and evaluate learners' performance. Learners can login to the LMS and access their profile from the database via users' interface. They review the course catalog and choose the courses they need. They can also search their desirable topics, and the LMS will dynamically find the courses in a repository of content for them.

The LCMS can manage the content which will be provided online, whether it is a customized content or off-the-shelf coursewares. It will provide a multi-user environment. In the environment, authors can use media creation or knowledge capture tools to create or capture e-Learning content from a central repository. Existing contents include off-the-shelf and proprietary courses. They may be text, html, multimedia, java applets, assessments formats, and so forth.

Delivery systems can provide a way for learners to interact and collaborate with instructors and other learners. It uses technologies such as voice over IP, video, whiteboard, feedback tools, breakout rooms, application sharing, and evaluation tools to create a classroom environment. The e-Learning system will be integrated to the traditional training management, performance support, ERP and CRM systems [6]. Major content vendors will support corporations with learning catalog from their content database and ERP system legacy applications. Moreover, it can also connect to customers' websites.

## 7. Choose E-Learning Strategies

Although the e-Learning system for e-Business can help corporations in many different ways, according to DigitalThink [4], the following three kinds of strategies – “workforce transformation”, “sales channel optimization”, and “customer education” strategies will best benefit corporations with highest Return on Investment (ROI). Each of them will be e-Learning enabler for setting up the system. If e-Learning project leaders need to figure out the ways e-Learning system can benefit them, please spend some time understanding the following statements and descriptions.

First, what will “workforce transformation strategy” benefit corporations ? It will increase productivity, reduce traveling time, reduce training unit costs, deliver more trainings with the same budgets, and cause higher retention of employees. It will help corporations to save more time and money to hold employees' training courses. It is also intended to improve skills, knowledge, and performance of employees.

Second, what is “sales channel optimization strategy” ? What services will the e-Learning system provide to sales departments ? It will increase time to market, updating flexibility, delivery speed and time spent on selling. The e-Learning system can allow corporations to upload the

latest product introduction files. Salesmen can download and present the files to customers. Whenever new product specs, information or open issues are posted on the e-Learning system, salesmen can get them from any place and any time when needed.

Third, “customer education strategy” will be discussed. What will the e-Learning system support for customer education ? It will provide courses for customer education, improve customer services and satisfaction. It will be a new huge ongoing revenue source for corporations. In addition to classroom trainings, e-Learning system will also give fee-based online classes to customers. It will be more effective and time independent. Also, it will attract new customers and business.

The above reasons just give some guides for strategies that will benefit corporations. It will help to get strategies needed. After corporations have viewed the explanations, please choose the one that best fits into the corporate needs. If the strategies have already been chosen, please go to define e-Learning objectives for next step procedure.

## 8. Define E-Learning Objectives

There are two types of objectives mentioned below, “business” and “training” objectives [4]. As mentioned in the last section, corporations will choose e-Learning strategies first, then related e-Learning objectives which meet the chosen strategies have to be setup. Please define e-Learning objectives that best fit into corporate needs by using the following information. Figure 6 illustrates “two types of e-Learning objectives”.

What are “business objectives” ? They include three kinds of objectives according to DigitalThink [4]. They are defined especially for business reasons and requirements. What are they ? They are “workforce transformation objectives”, “sales channel optimization objectives”, and “customer education objectives”. What are “training objectives” ? They are the objectives to provide learning plans, improve ability to access training resources, and off-the-shelf courseware integrations. It will also setup the high availability and performance web infrastructure of e-Learning system for e-Business.

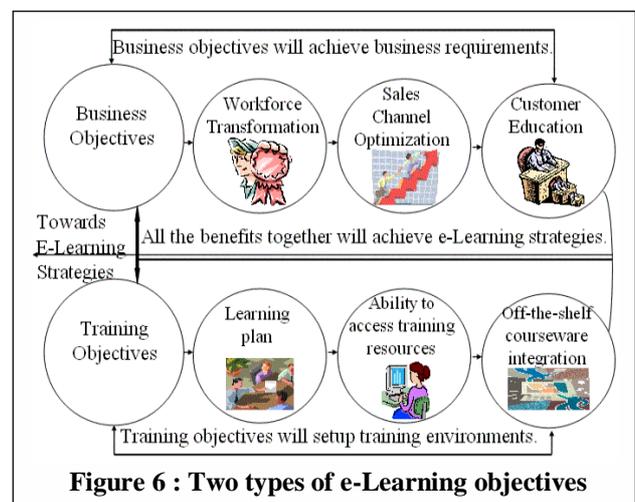


Figure 6 : Two types of e-Learning objectives

<b>Table 2 : Business objectives</b>			
<b>No</b>	<b>Item</b>	<b>Duration</b>	<b>Objectives</b>
<b>Workforce transformation</b>			
1	Course completion	10/01/02 ~ 12/31/02	Increase by 30%
2	Employee retention	10/01/02 ~ 12/31/02	Increase by 30%
3	Training costs	10/01/02 ~ 12/31/02	Decrease by 20%
4	Productivity	10/01/02 ~ 12/31/02	Increase by 20%
5	Travel time	10/01/02 ~ 12/31/02	Reduce by 30%
<b>Sales channel optimization</b>			
1	Time to market	01/01/03 ~ 03/31/03	Increase by 25%
2	Knowledge to market	01/01/03 ~ 03/31/03	Increase by 35%
3	Sales	01/01/03 ~ 03/31/03	Increase by 30%
<b>Customer education</b>			
1	Customer education revenues	04/01/03 ~ 06/30/03	Increase by 20%
2	Customer satisfaction	04/01/03 ~ 06/30/03	Increase by 50%

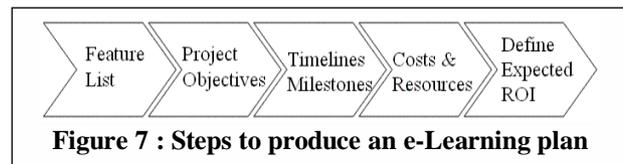
  

<b>Table 3 : Training objectives</b>			
<b>No</b>	<b>Item</b>	<b>Duration</b>	<b>Objectives</b>
1	Learning plan	10/01/02 ~ 10/31/02	Setup a good plan
2	Access to training resources	11/01/02 ~ 11/30/02	Improve access abilities
3	Off-the-shelf offerings integration	11/01/02 ~ 11/30/02	Make content better

Table 2 and 3 shows some examples of business and training objectives which can be chosen. Please review them and get more information about what they will be alike. Discuss with project teams and choose desirable business and training objectives. Make sure reasonable objectives are expected. After that, please find suitable vendors that can serve corporations with solutions for the implementation of e-Learning system.

## 9. Produce E-Learning Plan

A solid e-Learning project plan will help to keep the project on track. Also, it will be the primary means of communication for the project team. With combinations of DigitalThink [4] and this research, five steps are suggested and introduced. Figure 7 shows steps to produce an e-Learning plan.



First, “a feature list” must be included from reduced business and training objectives before producing the business plan. It shall include web tool being used, target audience, technology limitations, delivery deadline, funding available, subject matter experts, vendors, elaborate breakdown structures, estimates of staff hours, and budgets, and so forth.

Second, “list project objectives for the e-Learning system”. There are business and training objectives. In order to achieve the chosen objectives, information that are needed to accomplish must be detailed. For examples, reasons for achieving objectives, persons who will be in charge, priorities, time to start and end, and money needed.

Third, “list timelines and milestones”. They must include the following items : current tasks due days, next week’s tasks , tasks accomplishments , meetings held and attended, additional issues and concerns. Each of the timelines and milestones shall be discussed. They must be set reasonably and carefully. They will be checkpoints of whether the project is on-time or delayed. If the project is delayed, please find out what the problem is and try to adjust the pace.

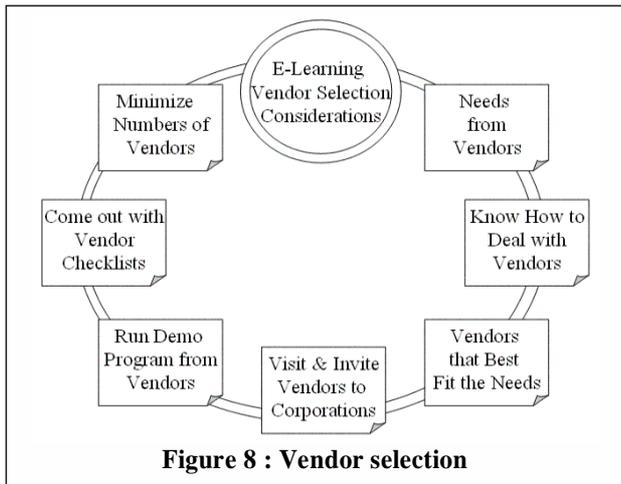
Fourth, “list costs needed and resources available”. Component costs include instructional design services, authoring software, training registration fees, and so forth. Please provide the realistic estimation of component costs. Resources will be budget, facility and technical engineers available for implementing the project.

Finally, “define expected ROI of e-Learning system”. It is the expected value of the e-Learning system. It will give some ideas about whether the e-Learning investment is worthy or not. Also, it will be a good project reason if the ROI is high enough for top managements to decide to have investments on e-Learning. It shall be adjusted when true e-Learning ROI is calculated.

## 10. Vendor Selection

It will suggest some general considerations on how to choose suitable vendors. IT departments may need new technologies to setup the e-Learning system. They can get them from e-Learning solution vendors. Vendors will provide what corporations need and gain feedback from them. Suitable vendors will shorten implementation time and help to guarantee a successful e-Learning system for e-Business.

There are three kinds of vendors : content, technology, and service [4]. Vendors of content will sell off-the-shelf coursewares. They can also work with corporate subject matter experts to produce customized courses. Vendors of technology will build e-Learning system infrastructures



**Figure 8 : Vendor selection**

and provide related technologies, for examples, installation of LMS / LCMS and integration technology of chatrooms and virtual rooms. Vendors of service will support to train tutors, develop a custom portal, integrate back end systems, and so forth. Figure 8 shows seven considerations for selecting good vendors [8].

Step one is “needs from vendors”. Corporations must know their budgets and what kinds of supports they need from vendors. They must provide RFPs which list content, technology, or service requests clearly to vendors. They will receive proposals from vendors and review what are most appropriate and satisfactory.

Step two is “know how to deal with vendors”. If corporations already find some vendors that will satisfy their needs, please also be careful to deal with them. If they are dealing with big vendors, please be sure that vendors will assign the best professional experts to serve them until the implementation of e-Learning is finished.

Step three is “choose vendors that best fit the needs”. There are many vendors right now serving e-Learning solutions. Please choose the ones that best fit the needs. Spend some time to study vendors' solutions. Please check : Do they offer the latest technologies ? Do they earn money ? Do they offer good quality services ? The information will be helpful to find suitable vendors.

Step four is “visit vendors and invite them to corporations”. Visiting vendors helps to understand their real working environments. Do they have confidences with their products ? Do they understand their products clearly ? Also invite them to corporations to give some suggestions about corporate e-Learning situations. Listen to what they suggest and judge whether they understand the problems or not.

Step five is “run demo programs from vendors”. Please ask vendors to provide demonstration programs. Please let key users run them and give feedback to vendors. By doing so, corporations can choose the solutions that will of great helps. Never buy products that are never being tested under corporate environments.

Step six is “come out with vendor checklists”. After interviewing vendors, please come out with vendor

No	Check Item
1	How long have the vendors been in business?
2	Do the vendors get reliable e-Learning implementation experiences ?
3	Can they support the contents, services and technologies needed ?
4	How are their off-the-shelf courseware integration, content development and course delivery system look like ? Are they friendly and easy to use ?
5	Are the costs of their services reasonable ?
6	Will they transfer the e-Learning technologies to the corporation ?

checklists. It will give clear comparisons among different vendors. By viewing them, corporations can know which vendors best fit their needs. Table 4 shows a vendor checklist which contains six questions. By answering the questions, corporations can see which vendors are at the top of the checklist.

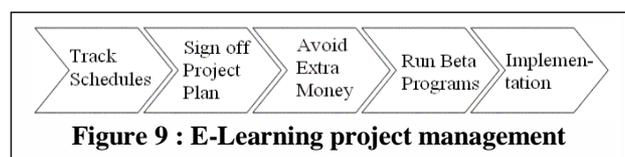
Step seven is “minimize numbers of vendors”. Choosing many vendors does not mean that all of them together will provide complete and satisfactory services. Choose the ones who will serve corporations with the best e-Learning solutions. Please have a stable and long-term relationship with them. Once corporations have finished choosing suitable vendors that will help them with the implementation of e-Learning system, please keep good communications with them.

## 11. E-Learning Project Management

There will be many elements needed to be controlled during the implementation, so please take a look at the following advices on how to manage a successful e-Learning project [2]. They are related to the e-Learning project plan which is proposed in this paper. Figure 9 depicts the chart of an e-Learning project management.

Step one is “track project schedule”. According to the e-Learning project plan, timelines and milestones are arranged. Please check whether the project is on-time or delayed. Regular meetings should be held to track project schedule. The following items should be checked : current tasks status and accomplishments, next tasks to be completed, issues and concerns. If the project is delayed, please find out the problems and try to solve them immediately.

Step two is “sign off project plan at each project milestone”. It will avoid scope creep and let the ones who complete the tasks to be responsible for the quality. When



**Figure 9 : E-Learning project management**

project team members attend meetings at the end of each milestone, they should sign off the project plan before they can move forward. The milestones of e-Learning system may expand within each phase when things go wrong.

Step three is “avoid spending extra money”. In order to control the budgets, please request a fixed-bid contract from vendors. Any “cost-plus” phrase in contracts should be avoided. It will prevent vendors from asking for extra money when the e-Learning project is delayed.

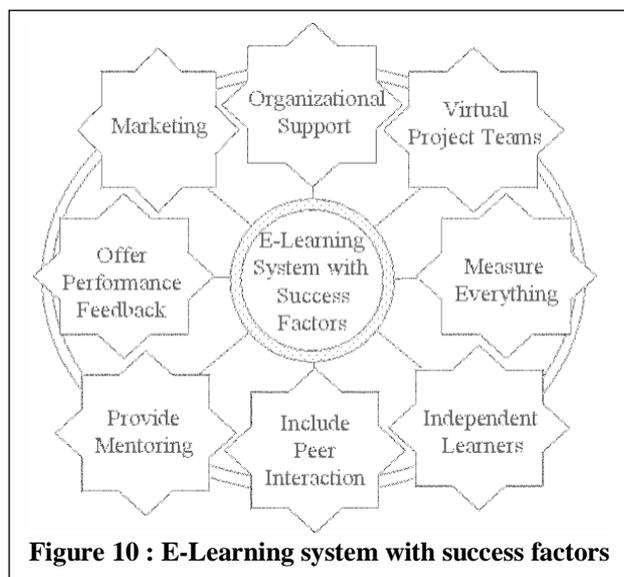
Step four is “run beta programs”. Please run beta programs from vendors in real corporate environments. Check if there are any bugs, misunderstandings about workflows, lacking of functions needed, inconvenience of user interfaces, and so forth. Gather them and feedback to vendors in writing. Wait for final e-Learning programs and test until they are ok for corporations.

Step five is “implementation”. Make sure there are engineers who will be responsible for the maintenance and use of the e-Learning system. Also, confirm with vendors to give training courses of the e-Learning system. By doing so, end users may learn how to use it. After a period of time, collect evaluation results on how they feel about the system. Improve the weaknesses and make it a more excellent system day after day.

## 12. Success Factors

E-Learning is just two years old and people are still experimenting how it works best. If an e-Learning system wants to run smoothly, what should be considered? The success factors will make the e-Learning system grow up and function properly. If corporations apply them, it will be easy for them to be successful. Figure 10 shows the e-Learning system with success factors [1] [3] [9].

The first one is “organizational support”. If top managements have fully supported on the e-Learning system usage, employees will have to practice more on how to use it. If it will be included in appraisal and salary review process, it will soon be one important part of employees' daily work.



**Figure 10 : E-Learning system with success factors**

The second one is “virtual project teams”. Members from different departments will create the virtual project teams. They will be from CEO, HR, IT, financial, sales departments, customers and vendors. They will contribute their unique skills, knowledge, or technologies to help setup the e-Learning system. They will conquer barriers across departments and implement the e-Learning solutions.

The third one is “measure everything”. It will help corporations to know where the starting and balancing points are. It will help to find out what strategies and objectives should be included or improved. Different stakeholders must be assessed to know their abilities and expected growth from the e-Learning system. The expected ROI should be set to compare with the real ROI to see whether the learning results of the e-Learning system are effective or not.

The fourth one is “independent learners”. Although the e-Learning system will try its best to be friendly and interactive, learners still have to be independent. Because web environments are quite different from a physical classroom. No instructors will push them to learn, they must learn at the required period of time. Independent attitudes will help them to learn online courses by themselves.

The fifth one is “include peer interaction”. If learners can have peer interaction by using message boards, chatrooms, communities, and so forth, they will like to spend more time on the e-Learning system. They share their ideas, experiences, and knowledge to one another from the network. By using the collaborative environment, learners will return to the e-Learning portal often.

The sixth one is “provide mentoring”. With the help of instructor mentoring, learners can avoid confusion situations about learning topics or processes. When learners take self-paced courses, they sometimes will get some questions about the e-Learning system. Maybe they will feel stuck and do not know what to do. They can either ask online instructors or e-mail their problems for advanced help.

The seventh one is “offer performance feedback”. The pretest determines learners' strengths or weaknesses. It will assess the level of learners and suggest needed courses for them to take. More over, learners can answer review questions at the end of the lessons. Learners have to wait a period of time before they can get feedback in traditional trainings. But the e-Learning system can offer performance feedback to learners, they can know their learning results immediately.

The eighth one is “marketing”. Since the e-Learning system includes customer education and satisfaction, it will be valuable and important to know how they feel about the system. Corporations must know why people want to use the e-Learning site. They must setup customer education objectives to motivate customer to use the e-Learning system. By having a good marketing, the investment of e-Learning will be adjusted to the directions which customers need and prefer.

### 13. Challenge Factors

Poor project management, undefined scopes, or no guide and roadmap to follow during the project's life cycle will harm the e-Learning system. So it is very important to know what will be the challenge factors during the implementation of e-Learning system and to avoid them in advance. There are eight challenge factors listed and discussed after [4]. Please refer to Figure 11 for the chart. Each of them will threaten the normal behaviors of an e-Learning system. The e-Learning system will have to work harder to conquer the challenges or be very weak to serve the audiences well.

The first one is “correct target setup”. Different stakeholders should be together to setup correct targets. They must decide what the business requirements are – workforce, sales channel or customer education. Also, target audiences should be correctly set. It will give good results in case there is a good strategy and plan set in advance.

The second one is “LMS / LCMS configuration”. Be aware of how the portal and tracking system are built. If they can work successfully, they will be helpful to keep good tracking of the audiences. Thus the learning evaluation results of employees will be convenient for top managements to review.

The third is “tutors and subject matter experts (SMEs) integration”. They will give the e-Learning system good services and helpful courses. It will need IT departments to work with tutors and the subject matter experts. It will help the audiences to use the e-Learning system with great satisfaction.

The fourth one is “content creation”. Decide whether to build or buy the necessary content. Whether the content is friendly or not will impact learners' attitudes towards the e-Learning system. In order to keep attentions and interest, IT departments have to create interactive and attractive contents.

The fifth one is “multiple modes of learning”. Since the e-Learning system have to serve different kinds of

learners, like CEO, managers, employees, salesmen, and customers, it has to provide a flexible approach for them to use. It needs to be engaging to the audiences.

The sixth one is “back end systems integration”. There will be many data needed for the e-Learning system to process, some of them are coming from ERP and CRM systems. For example, customer education services may need data from CRM system. The seamless integration among them will help the e-Learning system to be more powerful and useful.

The seventh one is “web infrastructure”. The system needs to serve many audiences at the same time, it will be very important to implement a high availability and performance web infrastructure. It must provide a fast and truly interactive interface for learners to get the content they want quickly and easily.

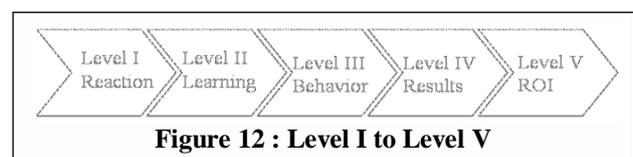
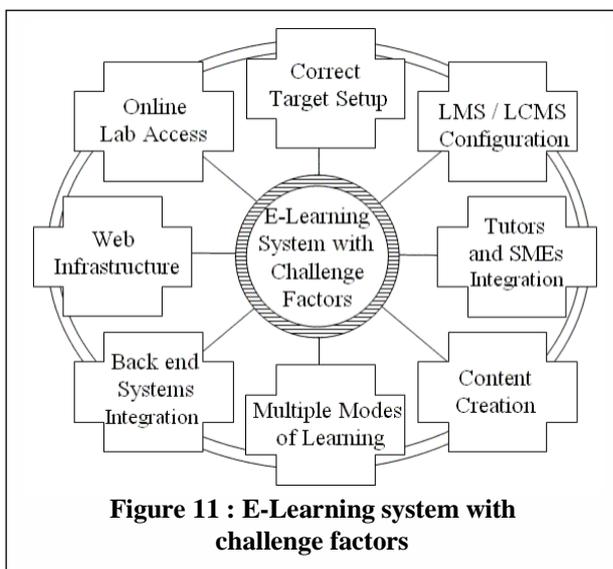
The eighth one is “online lab access”. It is necessary to help the audiences to do online access. Many of them need to be trained on the methods of using online lab. Please teach them well on how to use the system before they can have habits to do so.

### 14. Evaluation and ROI

Finally, the e-Learning system must include a systematic method to gather information about the impact and effectiveness of a learning event. The measurement results can be used to improve learning offerings, determine whether business or training objectives have been achieved, and assess the value of the learning event to corporations. Donald Kirkpatrick developed four levels which was laid out in “Evaluating Training Programs: The Four Levels.” Jack Phillips enhanced them and developed another level – Level V, to calculate corporate return on investment (ROI) [7].

Corporations can measure training effectiveness to know whether the investment in training is worthy or not. Corporations can get useful information when calculating the four factors or four levels. Each level of them cannot be used separately. There is a chain of effect among the five levels. Each level of measurement depends on the previous level, as well as the next. This paper introduces the meanings of them and gives three examples of ROI. Figure 12 depicts a Level I to Level V chart.

Level I measures “reaction”. It measures reaction of learners to training programs and whether they fit what they plan to learn from them. It will ask learners if they get useful skills and knowledge for their daily work. “Smile sheets”, which include surveys, questionnaire, or similar evaluation methods, are also provided to measure whether learning plans fit learners' expectation or not. The measurement can show that whether the training courses are meaningful or enjoyable to learners.



Level II measures “learning”. It will examine learners to see whether they achieve the skills or knowledge presented in the training programs by giving achievement tests, or whether the attitudes have been changed or acquired. It will compare “before” and “after” assessments and see to what extent have been improved after the training courses.

Level III measures “behavior”. When a training course is finished, changes of learners' working behavior will be observed. To observe learners in working environment will understand if they do what they have learned. This will calculate the training impact on learners' working.

Level IV measures “results”. It checks whether the on-the-job application does produce measurable results. If it is a sales training, it can be calculated by the increasing and decreasing of its revenues. It proposes the question of how many returns that corporations invest in trainings are gained.

Level V measures “return on investment” It checks whether the training return is greater than the investment or not. When performing the mathematical calculation of the ROI calculation, three data points are required : time period, investment, and return. According to “Calculating the Return On Your eLearning Investment” [5], there are three kinds of ROI evaluation : percentage, ratio and time to break-even. To have a more clear understanding, table 5 shows three ROI examples when fixed values : time period = 12 months, total investment = \$125,000 and return = \$500,000 are given. The ROI values will be : percentage is equal to 300%, ratio is equal to 4:1, and time to break-even is 3 months or 90 days.

## 15. Conclusion

This paper provides a good e-Learning guide and roadmap. There are useful approaches and considerations proposed to help corporations which are getting started with the implementation of e-Learning system. There are no doubts that all the topics in this paper help to setup a successful e-Learning system for e-Business.

**Table 5 : Examples of different ROI**

Three kinds of ROI	Formulation	Result
Percentage	$\frac{[(\text{Return}-\text{Investment})]}{\text{Investment}} * 100$ $= \frac{[(\$500,000-\$125,000)]}{\$125,000} * 100$	300%
Ratio	$\frac{\text{Return}}{\text{Investment}}$ $= \frac{\$500,000}{\$125,000}$	4:1
Time to break-even	$\frac{(\text{Investment}/\text{Return})}{* \text{Time Period}}$ $= \frac{(\$125,000/\$500,000)}{* 12 \text{ months}}$ $= (0.25) * 12 \text{ months}$	3 months or 90 days

Different stakeholders get their own responsibilities and jobs. CEO needs to give continuous supports. HRD and ITD will take advantages of the new training technology and provide a successful e-Learning system environment. Financial departments help to control investments and revenues. Employees improve job skills and knowledge. Salesmen improve performances on selling products. Customers can get educations and great satisfactions.

Clear understandings of inside and outside corporate environments will let corporations know where they stand. Correct strategies and objectives will setup successful directions. Suitable vendors will help to provide necessary contents, technologies, and services. Consistent project management will guarantee the quality of implementation. Success and challenge factors together to suggest overall notices for a better e-Learning system for e-Business.

If real ROI exceeds predefined ROI of the e-Learning system, the implementation of e-Learning system for e-Business can be proven to be successful. Otherwise, if predefined ROI exceeds real ROI, it means that the implementation is not as good as expected. Discuss with e-Learning project teams will help to find out what should be improved. Please adjust strategies, objectives, and ROI expectations of next year. Corporations can measure and gather different ROI year after year. They can compare what the improvements or changes are when comparing ROI of different years.

## References

- [1] Cisco. *E-Learning Solution Implementation Success Factors*, 2001, [http://www.cisco.com/warp/public/10/wwtraining/elearning/implement/success\\_factors.html](http://www.cisco.com/warp/public/10/wwtraining/elearning/implement/success_factors.html)
- [2] Darin Hartley. *Bankruptcy-Proof Your E-Learning Project*, December 2001, <http://www.learningcircuits.org/2001/dec2001/hartley.html>
- [3] David Price and Patrick von Schlag. *Bringing Classroom Curriculum Up to E-Speed*, September 2001, <http://www.learningcircuits.org/2001/sep2001/price.html>
- [4] DigitalThink. *The Corporate E-Learning Solution*, 2000, <http://www.infotoday.com/KMWorld2000/presentations/WhitePaper.pdf>
- [5] Docent, Inc.. *Calculating the Return On Your eLearning Investment*, September 2001, [http://www.docent.com/elearning/ROI\\_01.html](http://www.docent.com/elearning/ROI_01.html)
- [6] Harvi Singh. *Achieving Interoperability in e-Learning*, March 2000, <http://www.learningcircuits.org/mar2000/singh.html>
- [7] John L. Setaro. *Many Happy Returns: Calculating E-Learning ROI*, June 2001, <http://www.learningcircuits.org/2001/jun2001/learn.html>
- [8] Marc J. Rosenberg. *E-Learning : strategies for delivering knowledge in the digital age*, McGraw-Hill, 2001, 273-277.
- [9] Michael Brennan, Susan Funke and Cushing Anderson. *The Learning Content Management System*, 2001, <http://www.internettime.com/itimegroup/lcms/IDCLCMSWhitePaper.pdf>
- [10] Tom Barron. *Learning Object Approach Is Making Inroads*, May 2002, <http://www.learningcircuits.org/2002/may2002/barron.html>

# Making a Case for Collaborative Business Planning: Educating Information Management and Systems Graduates for the Knowledge-Based Economy

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## Abstract

This paper presents and discusses the design and evaluation of an innovative educational exercise that combines elements of both learning about and learning for e-commerce. The principle guiding the design of the exercise was the provision of an opportunity for postgraduate information management and information systems students to learn about and for e-commerce through the collaborative development of a business plan. A survey distributed at the end of the module collected data on students' acquisition of knowledge and skills related to their learning about and for e-commerce on the business plan exercise. The data analysis focuses on students' acquisition of knowledge and skills relevant to entrepreneurship, and demonstrates that the collaborative development of a business plan can be an effective learning tool for students to acquire not only specific domain knowledge of e-commerce topics such as business strategy, e-commerce business models, and e-commerce technology, but also generic information, communication, and management skills, relevant to learning about and for entrepreneurship.

## 1. Introduction

As a response to the competitive challenges of the knowledge-driven economy, the United Kingdom (UK) government recently published a report encouraging higher education institutions to incorporate learning for enterprise into their curricula [4]. The UK government's promotion of enterprise has also included the award of grant support to universities via the government's Science Enterprise Challenge. Support from this grant led to the establishment in 1999 of the White Rose Centre for Enterprise (WRCE) (<http://www.wrce.org.uk/>). This paper reports on the first stage of the WRCE-funded project called Managing Innovation in the Digital Economy (<http://www.wrce.org.uk/elbidshf.htm>). This project aims to incorporate enterprise learning into postgraduate and undergraduate curricula in information management and information systems.

Higher education curricula for e-commerce can be broadly considered to be of two types: curricula about e-commerce and curricula for e-commerce [7]. A curriculum designed for students to learn about e-commerce normally focuses on introducing and

developing conceptual models of e-commerce. The approach is taught in a conventional manner through lectures, textbooks, and essay writing. A curriculum designed for students to learn for e-commerce aims to create a learning environment that enables students to acquire knowledge and skills relevant to the practice of e-commerce. This paper presents and discusses the design and evaluation of an innovative educational exercise that combines elements of both learning about and learning for e-commerce. The principle guiding the design of the exercise was the provision of an opportunity for postgraduate information management and information systems students to learn about and for e-commerce through the collaborative development of a business plan.

## 2. Entrepreneurship and the Knowledge-Based Economy

An entrepreneur is commonly considered to be someone who starts up their own, new, small business. Not every new small business start-up represents an example of entrepreneurship though in its economic sense. The concept of entrepreneurship rests on economic theory that argues that the entrepreneur "shifts economic resources out of an area of lower and into an area of higher productivity and greater yield" [3]. This definition taken from the eighteenth century economist, J.B. Say, was intended as a manifesto and a declaration of dissent: the entrepreneur upsets and disorganizes. In the same vein, the economist Joseph Schumpeter has postulated that changes, which upset economic equilibrium, are due to an innovative entrepreneur who sees change as the norm and as healthy to economy. These changes are considered to be opportunities for the entrepreneur to innovate, to create new ways of doing things, and to create resources for further economic and social development. It is in this context that the management theorist, Peter Drucker defines entrepreneur and entrepreneurship as follows: "the entrepreneur always searches for change, responds to it, and exploits it as an opportunity" [3].

The concept of entrepreneurship is often allied with the concept of innovation. Such innovation does not have to be a technical innovation or even result in a tradeable product. An innovation can be social, for example, changes in an education system or a national health service can be considered to be social innovations because they have a profound impact on society and economy as a whole.

Entrepreneurs and the practice of entrepreneurship can be found in every walk of life and in any organization.

During the technology boom of 1999-2001 an increasing number of entrepreneurial initiatives were undertaken on a global scale. Indeed, the Internet commentator Manuel Castells writes: “without the action of these entrepreneurs, oriented by a specific set of values, there would be no new economy, and the Internet would have diffused at a much slower pace and with a different range of applications” [1]. The launching of these entrepreneurial initiatives was most popular among the young. This was in part because younger generations are exposed to new waves of technology development to a greater degree than older generations. Younger generations also possess a heightened awareness of the potential business opportunities offered by such technologies (e.g. Boo.com, Lastminute.com, Yahoo.com). Unlike their older counterparts however, younger people can often lack essential experience in planning, organizing, and managing businesses; and this lack of experience has been a contributing factor in the failure of many dot.com businesses to make a sustainable profit and subsequently collapse when their initial cash flows have dried up.

In the new economy, traditional methods of conducting business still persist. In addition to these traditional methods however new business instruments and thinking are required too. In the new economy, where knowledge-based products and services are the source of organizations’ competitiveness, there are a variety of technologies to support the development and distribution of these products and services. The value of these knowledge-based commodities rests on their symbolic representation of information and not on their manufacturing value. Hence organizations need to be able to represent and manipulate information effectively. Modern technologies, particularly digital technologies, can be employed to support the production and consumption of such symbolic or intangible goods.

In a knowledge-based economy, network technologies represent both an opportunity and a threat for organizations. On the one hand such technologies act as tools that can help accelerate the process of innovation within an organization, at both technical and organizational levels. On the other hand the speed of replication that networks afford, particularly with regard to the production and consumption of digital products, can represent a competitive challenge. This duality of opportunity and threat makes engagement in innovation a key function in the knowledge-based economy: “in an e-economy based on knowledge, information, and intangibles...innovation is the primordial function” [1]. Although some commentators have argued that it is not possible to plan for innovation, manage it, or design organizational structures and processes to support it, other commentators have suggested that a systematic approach to the innovation process can be taken. One such approach

suggests that there are five elements to the entrepreneurial innovation process. These elements are: preparation, incubation, insight, evaluation, and elaboration [5]. Each element involves a set of knowledge and skills that a successful entrepreneur is expected to have acquired.

## 2.1 Preparation

Opportunity recognition (OR) is the initial stage of the entrepreneurial process. OR can be defined as “either a) perceiving a possibility to create new business or b) significantly improving the position of an existing business, in both cases resulting in new profit potential” (Christensen, Madsen, and Peterson, 1989, quoted in [5]). The same argument is shared by others (e.g. Kirzner, cited in [5]) who state that the discovery of opportunities is the core issue of entrepreneurship. Hills et al. [5] define preparation as the background and experience that an entrepreneur brings to the opportunity recognition process. In the context of the current paper, an entrepreneur needs a knowledge base to draw on in order to identify opportunities. This knowledge base usually derives from an individual’s personal experience, education and training, and knowledge of particular fields.

## 2.1 Incubation

Incubation is the part of the opportunity recognition process in which the entrepreneur contemplates ideas or specific problems. Hills et al [5] and other commentators argue that incubation is neither about conscious or scientific problem-solving nor about systematic analysis, rather it is about having an intuitive sense of problems, and involves unstructured thinking of alternatives to the problems faced.

## 2.2 Insight

Unlike incubation which refers to an ongoing process, insight usually refers to a moment of recognition. Three types of insights may occur. First, is the experience of a spontaneous recognition of a business opportunity or of a solution to a problem. Second, is the moment when a person seizes the idea that solves the problem that they have been considering for some time. Third, is the recognition of a business opportunity or problem solving idea that arises from a person’s participation in a social network. Recent research has indicated that entrepreneurs with a wider network of social contacts and comparatively greater social capital are more likely to succeed compared to those with a narrower network of social contacts and less social capital.

## 2.3 Evaluation

Evaluation is the stage at which insights are analyzed systematically. This involves a series of activities which validate the ideas. These activities include research into

whether a concept is workable, whether the idea is original and has potential, whether the idea creator has the knowledge and skills to achieve it, and whether there is a market for the development of new products.

## 2.4 Elaboration

Elaboration is the phase at which creative insights, subjected to systematic analysis at the evaluation stage, are converted into a form ready for final presentation. It is at this stage that the practical details of the business idea are worked out with care. Entrepreneurship has always been associated with the image of high risk business however Hills et al. [5] argue that it during the process of elaboration that the skillful entrepreneur engages in planning activities in order to reduce risk. These five elements of the entrepreneurial process are by no means sequential and linear. Feedback from later stages to earlier stages is possible. The results of the evaluation stage for example may need to be fed back to the incubation stage for more earnest consideration. Similarly, during the elaboration stage individuals may be asked to feedback to earlier stages of the process in terms of further preparation, incubation, insight, and evaluation.

During the process of entrepreneurship a number of factors will have an overall impact on the process including personal traits, personal cognitive style and social competence. Social competence has become increasingly important, as a substantial proportion of creative insights are generated by teams of entrepreneurs rather than single individuals and new ventures usually need to obtain their venture capital from the market. It can also be argued that social skills such as impression management, social perception, and persuasiveness strongly affect the outcomes experienced by individuals in many contexts including job interviews, yearly performance reviews, and negotiation. In addition, social competence will have an impact on face-to-face interaction between individuals within the same entrepreneurial team, and between potential entrepreneurs and investors. It can also be argued that effective interactions with others may help entrepreneurs in performing important tasks such as negotiation, raising capital, building business relationships with suppliers and distributors, and so on.

Bearing the above arguments in mind, we argue that the facilitation of students' acquisition and development of the necessary knowledge base and skills needed to engage in the entrepreneurial process should be at the heart of teaching entrepreneurship. As discussed earlier, each step of the entrepreneurial process involves a set of activities and those activities require particular knowledge and skills in order to generate the input required for subsequent activities. The teaching of entrepreneurship should focus on developing the necessary knowledge and skills for each step and for the process as whole.

Table 1. Entrepreneurial knowledge and skills

Step	Knowledge	Skills
Preparation	Domain specific knowledge	Problem framing; identifying relevant information; information searching and location.
Incubation	Domain specific knowledge	Creative thinking
Insight	Domain specific knowledge	Problem solving
Evaluation	Domain specific knowledge	Identifying relevant resources; information locating, searching and gathering; synthesising data; extracting, evaluating and organising relevant information, industry analysis; critical analysis.
Elaboration	Business planning; marketing; project management; organisation and management knowledge, risk management.	Managing project; planning business; assessing risk; attention to detail; presenting data.

Table 1 summarizes the set of specific knowledge and skills that can be acquired in class. Social competence is assumed to be a generic interpersonal skill. Although social competence is not usually taught in an e-business and e-commerce classroom setting, it can nevertheless be learned by students as they engage in team-based educational exercises.

## 3. Curriculum Design

The E-Business and E-Commerce module is a postgraduate module designed mainly for delivery on the M.Sc. Information Systems (IS) and M.Sc. Information Management (IM) programmes, within the Department of Information Studies at the University of Sheffield. Both programmes of study are conversion programmes designed for those students who are interested in IS- or IM-related subjects but whose first degree may or may not be within an IS or IM discipline.

The curriculum design is based on two general observations of the business sector. First, the myth that the new economy has been caused by e-commerce or by the Internet. Indeed many commentators have overplayed the importance of the Internet or major new technologies (i.e. mobile computing, WAP) and underplayed the fact that economic law remains more or less the same [6]. This first

myth of the new economy leads to a second myth: that compared to the old economy, barriers of entry into business in the new economy are lower. A general feeling is that doing business online is easier than doing business offline and that it is easier to enter and exit an online market. This conception of e-commerce often leads individuals to believe that setting up an online business does not need to follow a series of procedures that conventional businesses would otherwise follow e.g. business planning, risk assessment, business model and strategy. Evidence demonstrates that the lack of detailed planning in many start-ups is one of the major reasons for their failure (<http://www.businessplanarchive.org/>). The curriculum design of the E-business and E-commerce module emphasizes the fact that the fundamental economic and business principles of e-commerce in the new economy are by and large no different from those of businesses in the old economy. Within the context of an increasing number of start-ups, many of them are noticeably run by young entrepreneurs [1]. In recent years, the British government has been committed to the promotion of enterprise and innovation in industry ([http://www.dti.gov.uk/for\\_business.html](http://www.dti.gov.uk/for_business.html)). The UK's Department of Trade and Industry for example provides various services to small and medium sized enterprises and start-ups in order to ensure that businesses receive necessary and adequate support from government. The Office of the e-Envoy was established by the British government to ensure that the country, its citizens and its businesses derive maximum benefit from the knowledge economy (<http://www.e-envoy.gov.uk/>). These initiatives aim to exploit innovations of any kind in order to sustain economic growth.

On the basis of the above observations the overall aims of the E-Business and E-Commerce module are (a) to emphasize fundamental economic and business principles and to give both traditional and new business models equal consideration; and (b) to encourage students to think creatively and provide an opportunity for them to experience the entrepreneurial process during the course. Three areas that the curriculum design is intended to address are: domain specific knowledge, intellectual skills and social competence. Domain specific knowledge refers to business-related knowledge, and in this case refers to knowledge of e-business and e-commerce in particular. Students are expected to develop domain specific knowledge through lectures, seminars, writing an individual essay, and doing a group assignment. This is learning about e-commerce.

Intellectual skills and social competence are expected to be developed through a group exercise set for the module: the collaborative development of a business plan. Through group collaboration in starting up a new business, students not only further their intellectual skills but also develop their social competence. This is learning for e-commerce.

### 3.1 Collaborative business plan

Students were asked to develop a collaborative business plan on the basis of one of three case scenarios developed for the module. These scenarios were drawn from three different industries: music, information, and retail. The first and second cases focus on the development of digital products and services, while the third case focuses on traditional retailing. Developing a business plan on the basis of these case scenarios takes students through an entrepreneurial process, from initiating business ideas (preparation) to planning details (elaboration).

The provision of case scenarios was in a number of ways similar to business case studies used for teaching and class discussion. First, the problem situation presented in the scenarios allowed students to step metaphorically into a decision-maker's shoes [9], where learning can take place through the submission and collaborative testing out of ideas, and the iterative application of the combined effort to the problem at hand. Second, the case scenario helps students to develop a set of principles and concepts that can be applied in practice [2]. Through the case scenarios students are able to develop their ability to identify problems, deal with complex and ambiguous situations, and to take decisions and determine action plans. Third, in order to provide solutions to the problems, in this case to develop a sound business plan, students need to apply their domain knowledge and bring appropriate tools to bear on their analysis of the problem. As has been suggested by others, such an approach helps students to develop a set of skills that includes applying their knowledge to complex situations, formulating critical analysis, and making decisions [6]. Finally, the case scenarios are intended to encourage students to make assumptions about how they might frame their business opportunity students have the flexibility to imagine different alternatives. This not only sharpens students' industry analysis skills but also encourages students to think creatively. Indeed such flexibility is essential to the students' entrepreneurial experience.

As mentioned above, three case scenarios were prepared to describe three different types of companies located in three different industries ranging from music, information and retail. Reasons for choosing these three industries are twofold. First, these industries are currently facing challenges caused by digital technologies. For example, the retail sector faces a dilemma of going or not going online because either option will afford different opportunities but at the same time present different challenges to retailers. The information industry is facing problems of pricing information on the Internet, while the music industry is facing pressure through falling CD sales and an increase in the number of music websites which allow free music download. Second, these three industries are close to students' everyday life and students are hence able to draw together their observation, experiences, and general knowledge to generate business ideas.

Students were expected to draw up a collaborative business plan on the basis of the scenarios. They had the opportunity either to launch a start-up company or to launch a new online products and services division within an existing offline company. The structure and content of the business plan should be almost the same as a standard business plan, consisting of an executive summary, company description, industry analysis, product and service, business model, marketing and business strategy, management team, and financial forecast. In order to develop their business plan, students were asked to analyze the case scenarios in order to frame the problems that the company currently faces, find information about the current developments in the industry in which the company is located, analyze the developments in the industry to evaluate their business ideas, and apply their knowledge of marketing and business to formulate their strategies. The exercise provided an opportunity for students to further their domain specific knowledge by applying it to the exercise and to develop their intellectual skills and social competence through interaction with fellow students.

### 3.2 Implementation issues

Thirty-four students signed up for the module for the 2001-2002 academic year. The student body was diverse in terms of nationality and gender. Fifty per cent of students were home students and fifty per cent of students were international students. The gender distribution of the group was also fifty-fifty. All students were assigned to a group of four by the module coordinator. The decision about assigning students to their groups rather than allowing them to choose their own groups in this instance is based on pedagogical grounds.

First, there can be a tendency towards a divide between home and international students with students from the same cultural background or country tending to work together. A gender divide can also occur. Female students tend to work with female students while male students tend to work with male students. In an effort to encourage students to work together regardless of cultural background or gender, the decision was taken to mix students evenly on the basis of these two criteria. Second, it can be argued that forming a diverse business team can help generate good ideas as people from different social, cultural and ethnic backgrounds are able to provide valuable contributions to business ideas from different perspectives. It can also be argued that nowadays working in a diverse work environment is almost inevitable and hence students should be prepared for working with individuals from different backgrounds. Third, through working in an international team, students' social competence can be further enhanced. There were eight groups in total and copies of the three case scenarios were distributed. Groups were asked to take a decision about which scenario they would develop for their collaborative business plan. In order to avoid a situation where students

over subscribed to a particular case allocation to each case was limited to a maximum of three groups. Three seminars were organized to provide groups with an opportunity to present their business plan to other groups and to gain feedback from tutors and their fellow students. In the first seminar, the groups presented their industrial and market analysis. In the second seminar, the groups presented their draft business plan. In the third seminar, the groups presented a near-completed business plan.

### 4. Learning outcome

During the course of the module students attended lectures regularly and prepared and presented their latest work every three weeks. An advisor from the university's technology transfer office was invited to give students feedback on their business plans. The following discussion presents the results of the questionnaire survey. The questionnaire was designed to evaluate the effectiveness of the exercise as a whole, and the collaborative development of the business plan in particular, within the context of learning about and for entrepreneurship. Learning outcomes identified in this paper focus on the knowledge and skills which students stated that they had acquired through participating in the business plan exercise. The questionnaire was distributed to the students at the end of the course. The students were able to decide whether they would like to participate in filling the questionnaire. The questionnaire received a good response rate with fifty-six per cent of the students on the course completing the questionnaire. Tables 2-5 summarize the findings relating to students' acquisition of knowledge and skills through their participation in the exercise.

Table 2. Students' acquisition of domain knowledge by percentage and rank

Domain Knowledge	Percentage	Rank
Business strategy	78.9	1.5
E-commerce	78.9	1.5
Business models		
E-commerce technology	63.2	3
Success and failure of e-commerce	57.9	4.5
Marketing	57.9	4.5
Digital market	36.8	6.5
Management	36.8	6.5
Knowledge	26.3	8
Management		
Value chain	21.1	9
Management		
Information management	15.8	10
Interface design	10.5	11.5
Project management	10.5	11.5

The data in Table 2 demonstrate that the three most valued areas of domain knowledge acquired through participating in the collaborative development of the business plan were: business strategy, e-commerce business models, and e-commerce technology. The need for sound business strategy and models is a recurring theme in the retrospective analysis of the dotcom boom and bust. Learning about 'success and failure of e-commerce' and 'marketing' were also considered to be important (57.9%). The value attributed by students as to the relevance of 'success and failure of e-commerce' is of particular note. The meaning of entrepreneurship traditionally incorporates the notion of risk and the risks attendant on entrepreneurship in relation to e-commerce enterprises are no exception.

Table 3. Students' acquisition of communication skills by percentage and rank

Communication skill	Percentage	Rank
Speaking effectively	94.7	1
Presenting and conveying ideas and information effectively	84.2	2
Writing concisely	68.4	3

Social competence is a key competence in order to participate effectively in the entrepreneurial process; and the data demonstrates how students ranked the acquisition of oral skills relating to speaking and presenting above those of writing skills.

Table 4. Students' acquisition of interpersonal skills by percentage and rank

Interpersonal skill	Percentage	Rank
Working effectively In a team	73.7	1
Listening to others	63.2	2
Being sensitive to others	57.9	3.5
Providing support For others	57.9	3.5
Developing rapport	52.6	5
Negotiating	47.4	6.5
Accepting criticism and acting upon it	47.4	6.5

Acquiring the ability to work effectively in a team is clearly an essential part of an entrepreneurial education and the findings demonstrate the clear value attached to this ability by the student body. The data also point to the other- rather self-oriented nature of enterprise development as part of a group dynamic. Listening skills, being sensitive to, providing support for, and developing rapport with others were also skills identified by the majority of students as being acquired. The students felt that listening skills and being sensitive to others are critical for working effectively in a culturally diverse team.

Table 5. Students' acquisition of organizational and management skills by percentage and rank

Organisational and management skill	Percentage	Rank
Decision-making	68.4	1.5
Accepting responsibility	68.4	1.5
Setting and meeting Deadlines	63.2	3
Managing time	57.9	4.5
Meeting goals	57.9	4.5
Planning and co-ordinating tasks	52.6	6
Attention to detail	36.8	7
Managing conflict	26.3	9
Enlisting help	26.3	9
Project management	26.3	9

Key skills identified by the students relate to the successful accomplishment and achievement of a collaborative exercise: decision-making (68.4%), accepting responsibility (68.4%) and setting and meeting deadlines (63.2%). The top ranking of these skills neatly highlights a logical sequence of decision-making, taking responsibility and achieving deliverables by a certain date.

Table 6. Students' acquisition of intellectual and research skills by percentage and rank

Intellectual and research skill	Percentage	Rank
Extracting, evaluating and organizing relevant information	57.9	1
Information locating, search and gathering	52.6	2
Creating ideas	47.4	3
Identifying and solving Problems	42.1	5
Applying critical judgment	42.1	5
Identifying relevant resources	42.1	5
Synthesizing data	36.8	7
Imagining alternatives	26.3	8
Initiating and recognizing information inquiry concisely i.e. what information	21.1	9

Of particular note in this aspect of the data set is the rating of information-related skills above those of the creation of ideas. Industrial and competitor analyses will have needed to have been carried out ahead of creating ideas for new enterprises.

## 6. Discussion

Domain specific knowledge acquired by the students is relevant to all stages of the entrepreneurial process: preparation, incubation, insight, evaluation, and elaboration. The emphasis placed by the students on acquiring knowledge of business strategy, e-commerce business models, e-commerce technology, and success and failure of e-commerce appears to bear this out. The healthy

ranking accorded to 'marketing' is also encouraging in that it demonstrates that a majority of the students were also following the entrepreneurial process right through to the stage of elaboration.

In regard to generic skills, the opportunity to and their ability to articulate and express ideas orally was highly valued. In the context of the entrepreneurial process this is again encouraging, where oral communication in teams, and presentations to external agencies forms a crucial part of effective entrepreneurship. Students acquisition of interpersonal skills bears out the importance of team-work in developing innovative processes. Students' acquisition of organizational and management skills appears to focus on group decision-making, a shared division of labour, and a number of process tasks related to keeping the task on track. There appears to be less emphasis on either asking for outside help and formal project management planning. The former may be encouraging in terms of group autonomy although the latter may be less encouraging. Interestingly, students acquisition of intellectual and research skills appears to have been concentrated on the preparation and evaluation stages of the entrepreneurial process. The higher ranking accorded to information-related skills above skills of creating ideas seems to suggest that many of the students were focused during the process particularly on researching the particular industry in which their case scenario was located and again evaluating their plan against real-world industrial cases.

## 7. Conclusion

In today's knowledge-driven business environment the ability to continuously innovate is regarded as a lynchpin of a company's competitive advantage. The survey results suggest that the business plan exercise has been an effective learning instrument through which students can acquire both domain knowledge and generic skills relevant to an innovative entrepreneurial process. Such a process of innovation, taken as a whole and in regard to the information-related and other creative and social skills that process incorporates is particularly pertinent to innovation in a knowledge-driven economy. How can this process and the skills which it incorporates be taught in the classroom? In this paper we have demonstrated that through a carefully designed exercise both domain knowledge and a set of

generic skills relevant to each stage of the entrepreneurial process can be developed. Teaching entrepreneurship can be not only about teaching students subject knowledge or knowledge about how to start and run a new business, but can also be about how to help and encourage students to develop their entrepreneurial capabilities e.g. identifying an opportunity, thinking creatively, communicating effectively. Learning entrepreneurship can then be a process of acquiring not only knowledge of business strategies and models and the application of these in organizational contexts but can also be about simulating intervention in the real-world through active participation in the collaborative development of business plans. We end with a caveat. Interested curriculum designers should ensure however that the design of such a learning environment is accompanied by a well structured learning process that supports and facilitates students' progress towards their business goal.

## References

- [1] Castells, M. *The internet galaxy: reflections on the internet, business and society*, Oxford University Press, 2001.
- [2] Corey, E. "The use of cases in management education". Notes prepared for the use of students of business administration. Harvard Business School, 1976.
- [3] Drucker, P.F. *Innovation and entrepreneurship: practice and principles*, Butterworth-Heinemann, 1985.
- [4] Great Britain: DTI/DFEE. *Opportunity for all: a White Paper on enterprise, skills and innovation*, HMSO, 2001.
- [5] Hills, G. E., Shrader, R.C., and Lumpkin, G.T. "Opportunity Recognition as Creative Process". In: *Frontiers of entrepreneurial research*, 1999. [http://www.babson.edu/entrep/fer/papers99/index99/index99\\_text.htm](http://www.babson.edu/entrep/fer/papers99/index99/index99_text.htm)
- [6] Huff, S. L., Jelassi, T., Cash, J., and Pifko, J. *Teaching information systems management with cases*, 2000. <http://ashley.ivey.uwo.ca/~isworld/article.html>
- [7] Levie, J. *Entrepreneurship education in higher education in England: a survey*, London Business School, 1999.
- [8] Shapiro, C. *Information rules : a strategic guide to the network economy*, Harvard Business School, 1999. <http://www.ivey.uwo.ca/isworld/caselrn.htm>
- [9] Szpiro, D.A. and Neufeld, D.J. *Learning information systems with cases*, n.d. <http://www.ivey.uwo.ca/isworld/caselrn.htm>

# Teaching Internet Entrepreneurship

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At the beginning of 2000, Cal Poly Pomona College of Business Administration launched a task force to create an undergraduate E-Business Program. Twelve faculty members worked hard to develop a core of six four-unit courses including practicum or senior project and then began work on six specialty career tracks.

#### Required Core Courses:

- EBZ 301: Introduction to Electronic Business.
- EBZ 302: e-Business Technology.
- EBZ 303: e-Business Customer Relationship Management.
- EBZ 304: e-Business-enabled Supply Chain Management.
- EBZ 305: e-Business Enterprise Resource Planning.
- EBZ 306: e-Business Startup and Development.
- EBZ 466: e-Business Practicum.

#### Specialty Career Tracks:

1. Accounting and Transaction Processing
2. Content Creation and Management
3. Customer Relationship Management
4. E-Business Entrepreneurship and Strategy
5. Enterprise Integration Applications
6. Supply Chain Management

The first course EBZ 301 was taught January 2001 launching the program. At the end of spring 2002 we have almost 200 enrolled in the program and have actually seen seven graduates with the EBZ option/concentration (business administration is major.)

This paper concerns the development of content and process for the course EBZ 306 E-Business Startup and Development, the sixth core course requirement for the EBZ concentration. It presents a model of the course as

presented and calls for suggestions for improvement as well as enhancement.

Having taught entrepreneurship for many years and been involved in the development of many entrepreneurship courses as well as degree programs; the importance of a combination of unique learning experiences was a very clear mandate.

Historic literature indicates a varied list of pedagogues as useful for stimulating learning in the entrepreneurial classroom. Ronstadt (1985) called for an "action-oriented approach . . . go out and do it. . ."

Winslow, Solomon and Tarabishy (1997)

. . . data indicate what teaching methods were offered. They include: (1) case studies (2) lectures of business owners; (3) development of business plans; (4) guest speakers; (5) research projects; (6) community development; (7) onsite visits; (8) creation of business plans; (9) discussions; (10) small business institute counseling (11) feasibility studies (12) internships.

In fact, numerous studies have revealed that traditional textbook/lecture is an inappropriate if not boring way to deliver entrepreneurial instruction. (Ahiarah 1989 and others.)

The treatment of entrepreneurship on the Internet comes with an obvious ready-made core pedagogical tool. Effective use of this tool and the instructional materials supporting it are not so ready. My [website for EBZ 306](#), a course I teach at Cal Poly Pomona is designed for both home research and in-class presentation. I shall begin with the components of this course:

## GRADING AND EVALUATION

The following weightings will determine student evaluations.

INDIVIDUAL - <a href="#">INTERNET RESEARCH EXERCISE</a>	10%
INDIVIDUAL - <a href="#">SELF DEVELOPMENT EXERCISE</a>	10%
INDIVIDUAL - <a href="#">FOUR ASSIGNMENTS</a>	40%
INDIVIDUAL - <a href="#">BOOK REPORT eBoys or Burn Rate</a>	10%
GROUP - <a href="#">E-BUSINESS WEB BUSINESS PLAN</a>	20%
CLASS PARTICIPATION, ATTENDANCE,	10%
<a href="#">TOTAL</a>	<a href="#">100%</a>

Each component is linked to the page description for the assignment or project.

The Internet Research Exercise contains 13 carefully constructed questions to expose students to be the best sources of Internet information on individual companies and industry trends, changes, conditions and forces, that is opportunities and threats. For example, here are two questions from the actual exercise:

1. The most significant source of information on publicly traded corporations is the [Securities and Exchange Commission -EDGAR Data Base](#). It is very important for finding corporate SEC filings. Always seek the most current "Form 10-K". Click on "Search Edgar Archives." Find the blank space and type in Yahoo or Yahoo Inc. Set "Start" to 1999 and "End" to 2002. Click return. Spot the most current 10-K (you may have to scan down the page.) Click on "Yahoo Inc." and find the financial statements. ([Confused? -- try the SEC Edgar Instructions/Tutorial](#).) Copy the "profit and loss statement" and paste it on to your assignment. This copy paste is acceptable as long as you cite the 10-K using the formats found at either: [American Psychological Association - APA Style.Org Or, Purdue University English Dept. interpretation of APA and other style sheets](#).

2. Industry Analysis - Though more vague and difficult to find, the researcher is searching for external dynamics. These might include -- industry: lifecycle, concentration levels, changes, trends, successes, failures, downturns, collapses, key industry players or biggest competitors. Unless the company is on the list of largest global influencers, they are not likely to be able to individually change or impact these external or industry conditions. In effect, these "externalities" are beyond control of the individual company.

Answer 1: In your own words, create a list of five industry conditions. (No, not from the Internet, just be creative and list five) Discuss why it would be important to research and utilize current information about these conditions when analyzing or researching a company.

For example: Let's assume that I am preparing a case -- say "Yahoo.Com." I must provide information about the appropriate industry/(ies) First, I must identify the industry -- probably by S.I.C. number.

Answer 2 in 11 steps: Step 1. Click on [Hoovers.com](#). 2. At the top click on "companies & industries," then, 3. click on "industries" from the immediate menu on the left. 4. Click on "Complete List" on right side of page. 5. Type "Yahoo" into the search box and hit return. 6. Click on "YHOO NASDAQ", then, 7. click on the "industry" tab - (found on right screen.) 7. hat is the SIC number, and 8. what is the industry name? 9. Click on "Media - Internet & Online Content Providers" 10. click on SIC tab - right screen. 11. What are the three SIC Codes

related to this industry?

Yes, these two questions are a bit confusing -- indeed by design. The student is forced to discuss the questions with team members and I can use them in class for extended oral discussion. I am a bit mean, I use this same question with MBA students and have a standing threat to fail a graduate student who does not know what a P&L statement is. The copy paste in question 1 leads to a discussion concerning plagiarism and paraphrasing. If links get stale, I reward the student who emails me this information first so that I may correct the exercise.

The individual self-development exercise, provides a choice of unique challenges. The student selects the one that appears to provide the best individual learning based on interest or career track choice. These include "check your credit" with the three US credit reporting agencies. I only want a photocopy of the credit agency name and student name turned in. A student's credit report is singularly his/her business, not mine. I feel confident, however, in the process of pushing the student to examine his/her own credit report. Many do not know that it exists. They also do not connect a future SBA small business loan with this report.

Other self development items include write an individual mini business plan, establish a working business on eBay, etc.

The four assignments are designed to be the heart of the course. They are:

1. Description of the Business Opportunity including a discussion of: (a) the [Internet business model](#), (b) description of customers/target market, the [eMarketing Strategy](#), including competitive advantage, (c) brief overview of competition, (d) expectations/benchmarks, (e) start-up capital requirements (f) [fulfillment](#), inventory, warehousing, [delivery](#), or outsourcing, and part 2 - the individual 3 page website.

2. A project to learn as much as possible about the March-April 2000 dot com stock correction. (a) Select and research one Internet dot com failure (such as Boo.com.) (b) Discuss at least five major reasons why it failed. (c) Include at least 10 characteristics of the successful dot com for the next generation.

3. Generate at least three alternative web hosts for evaluation. Weigh, evaluate and analyze these three resulting in a final decision with justification. Finally, develop a step-by-step plan and schedule, detailing how you will launch your business with this provider. Considerations in analysis: shared, co-located or dedicated service, factors such as customer and technical support, uptime guarantees, facilities that can outlast disaster, connection types to the Internet, speed, flexibility, scalability, security, backup, equipment, software, and of course prices.

4. Develop a three page marketing plan for the individual business you developed in Assignment 1.

The book report on eBoys or Burn Rate. These two books were selected to provide a picture of the “golden years” of the dot com run up. Both books are readable and allow students to see what happened and a little bit about why. They are meant to be historic accounts (yes, four years ago is history in the e-world, and I am 8 dog years old!)

Finally, the e-business web business plan utilizes a format developed from experience and several recommended formats. This is a group project and involves both a three page working website (transaction software cannot function on university servers) and an oral formal presentation before the class.

For in class lectures, I use the following PowerPoint presentations:

Topic:

Introduction

Start Up Ideas - The Opportunity

Setting Up a Budget and Sticking to It

Domain Names

Creating Online Branding

Provide Customer Service

Building Community

Setting Up Storefront

Understanding Back End and Hosting

Business Planning & Venture Funding

Promoting to Your Target Market

PowerPoint:

[Introduction](#)

[Start Up Ideas](#)

[Budget](#)

[Domain Names](#)

[Branding](#)

[Customer Service](#)

[Building Community](#)

[Storefronts](#)

[Back End and Hosting](#)

[Planning & Funding](#)

[Promotion](#)

Each slide in the presentations contains both information bullets and links to relevant websites. For example:

## Top Level Domains

- Seven new TLDs listed: <http://www.icann.org/tlds/>
- Introducing .biz – the new Internet domain built especially for business: <http://www.neulevel.biz>
- ***What's in a .name?***  
<http://www.gnr.com/> A *.name* domain has three 'levels'. The first level is the actual *.name* suffix and the second and third levels are your first and last name. So a *.name* web address will look like this: *First name.Last name.name* or *Last name.First name.name*. Your email address will be easy to remember too: *First name@Last name.name* or *Last name@First name.name*.
- Registry Whois Search: <http://www.internic.net/whois.html>
- The Accredited Registrar Directory -- Listing by Location of Registrar <http://www.internic.net/origin.html>

This slide provides interesting information supported with links. The students in the laboratory each can use the links to read the supporting information while the lecturer comments. Do they ever engage in “chats” or games with the little messenger while teacher is pouring out heart and soul, you ask? Oh yes, that is why the “freeze” on instructors screen button is so critical in the pc lab. I emphasize that “frozen comments” are just long enough to cause the loss of a friend or game!

These slides are available online and students are encouraged to use them at home.

### Pedagogical Materials

I have found the following textbooks to be useful in this course:

1. Kienan, Brenda, [Managing Your E-Commerce Business](#), 448 pages, Microsoft Press; ISBN: 0735612757; 2 edition (April 4, 2001)
2. Frank Fiore and TechTV. [TechTV Starting an Online Business](#). Que Corporation, 2001. August 2001 ISBN 0-7897- 2564-9.
3. [Annual Editions for Entrepreneurship 02/03](#). Robert W. Price, Senior Research Fellow, Global Entrepreneurship Institute; McGraw-Hill Dushkin, January 2002. ISBN: 0-07-252911-3,

Course objectives or expected outcomes are simple and achievable:

#### COURSE OBJECTIVES

- Identify business opportunities
- Classify business opportunities, e.g., start-up, process improvement, new marketing channel, etc.
- Evaluate opportunities, in terms of business potential and organizational feasibility
- Design an Internet start-up or new eBusiness program within an existing organization
- Write and orally present a business plan

Finally, the following rules are critical:

1. Downloading, Scanning, Copying and Rearranging to be used as the final project will not be permitted. Violations of this will be treated as major infraction of

Cal Poly cheating rules. The Internet provides invaluable resources for students and practicing professionals. We shall learn here how to use them effectively. You will want to download and use these resources. Simply do not use downloaded or scanned text as final assignments.

2. A roll sheet will be passed at most class meetings and each absence will count 2 percentage points off the students final weighted average. If you have what you think to be a 90 weighted average after all work is completed, two absences will result in lowering that average to 86 and you will receive a B. Excuses will be considered on an individual basis
3. Assignments will be accepted late on the last day of class, not on the day or class period after they are due. They will receive only partial credit and will not be returned. This is only somewhat better than getting a 0 for that assignment. Avoid this problem by turning each assignment in on the due date.

### Conclusion

The results have been good overall. The first two attempts without a computer laboratory were tedious and difficult to work. Students of e-Commerce must be engaged in Internet navigation. Most have been doing this since teenage years. This incredible new learning tool is there classroom, their reading materials and their careers -- interaction, navigation and motivation are the critical ingredients.

### Bibliography

- [1] Ahiarah, S. Strategic Management and Entrepreneurship Course at the Undergraduate Level: Can One Inform the Other? Proceedings of the 1989 SBIDA Conference, 1989.
- [2] Ronstadt, R. “The Educated Entrepreneur: A New Era of Entrepreneurial Education is Beginning.” American Journal of Small Business Vol. 10, 1985
- [3] Winslow, E. K., George T. Solomon, and Ayman Tarabishy. Empirical Investigation into Entrepreneurship Education in the United States: Some Results of the 1997 National Survey of Entrepreneurial Education. Proceedings USASBE, 1999.

# Teaching a Comprehensive Web Based Application within an IS Curriculum

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## Abstract

As Internet technologies have exploded over the past few years, corporations struggled to develop standards for managing their Internet resources. Since the passing of "Y2K," organizations have increasingly focused on developing an effective Internet presence. Consumer shopping on the Internet is expected to grow to around \$1 trillion by the year 2003, and Electronic Data Interchange (EDI) is expected to grow to around \$300 billion by the same year. With this escalating demand for Internet-based commerce, organizations are attempting to recruit IS personnel who can develop Internet applications, and they expect academic institutions to provide IS professionals with the skills necessary for this rapidly changing technological environment as well as traditional skills needed for the mainframe environment. With limited resources, academic institutions have been revamping their curriculum to accommodate the growth of the Internet and to maintain the more traditional IS core curriculum. By utilizing readily available computer hardware and software, academic institutions can provide an effective and active Internet learning environment.

## 1. Introduction

Preparing IS professionals is a challenge for academic institutions factoring in a rapidly changing technological environment. With the explosion of Internet technologies over the past few years, organizations have struggled to develop standards for effectively managing their Internet resources. Consumer shopping on the Internet is expected to grow to around \$1 trillion by the year 2003, and Electronic Data Interchange (EDI) is expected to grow to around \$300 billion by the same year (Grover, 2001). With this escalating demand for Internet-based commerce, organizations are trying to recruit IS personnel who can develop Internet applications, and they expect academic institutions to provide IS professionals with the skills that are needed for this rapidly changing technological environment as well as traditional skills needed for the mainframe environment. With limited resources, academic institutions have been revamping their curriculum to accommodate the growth of the Internet and to maintain the

more traditional IS core curriculum. The demand for both Internet and mainframe skills remains strong as indicated by the high salaries and vacant positions in the job market for IS professionals.

Eventually, the mainframe and the Internet (client/server) environments will have to be integrated into one complete, comprehensive system. Skills developed in the more traditional mainframe environment will have to be incorporated into a complex networking system that can seamlessly transfer information from one environment to another without giving up security or efficiency. The IS professional has to possess the skills for both environments; he/she will play the role of an integrator.

With limited resources academic institutions must provide these skills for their IS professionals. Much has been written concerning the implementation of mainframe base technology. Yet, how can academic institutions incorporate the client-server technologies of the Internet with traditional mainframe technologies? One of the most popular personal computer (PC)-mainframe configurations has been to provide a mainframe connection called a gateway to a local area network (LAN) where the PC becomes a terminal for the mainframe. Under this configuration academic institutions can access both PC and mainframe software. By utilizing computer hardware and software products already available on the PC, academic institutions can provide an effective and active Internet learning environment.

## 2. Tools

The software tools needed for the client-server environment can be readily found within the operating system of the PC and the common software products that academic institutions provide for their introductory classes to the PC environment. Software like Web browsers, text editors, and database management software are common components of a PC environment. Since students often use their own computers to work on projects at home or in their dormitory rooms, it is also important that resources be readily available for this use.

The client-server environment requires the operating system to be both a client computer as well as a server computer. This dual role demands software that can be

used to develop the client-side applications and software that can be used to emulate the server-side operations. Figure 1 illustrates this relationship.

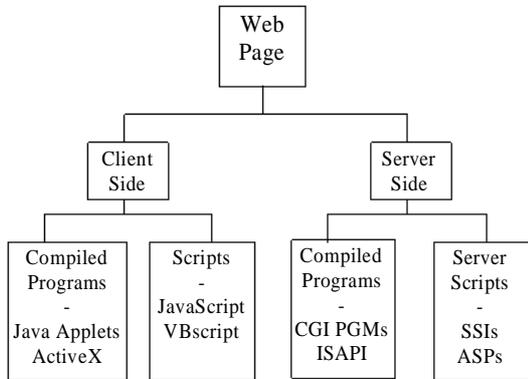


Figure 1. Client-Side and Server-Side Relationship

Web site development requires client-side components like Java applets, ActiveX, and scripting languages (JavaScript or VB Script). The server-side components are compiled programs called CGI (Common Gateway Interface) programs written in languages like Visual Basic, JAVA, PERL, ISAPI, or COBOL; and scripting languages like Active Server Pages (ASP) and Server-Side Includes (SSIs). Choosing components is a matter of surveying the market to find the most popular components or testing the components in typical Web applications to determine which performs the most effectively. Using the most common tools is a reasonable approach to this decision; Java Applets, JavaScript, and Active Server Pages are some common Internet components.

Windows 98 provides a web server manager software called “Personal Web Server” that can support server-side applications. Either Netscape or Internet Explorer can support client-side applications. The database management software called ACCESS is a common database management tool that can be used to illustrate database applications on the Internet. ACCESS is a relational database that can be accessed and updated using the Structured Query Language (SQL). Microsoft’s SQL Server is a more industrial strength database management system that can be upsized from within ACCESS. Both relational databases and SQL are the most common database components on the Internet today. Students can also acquire ACCESS at a considerable discount for their home use.

## 2.1 Setup

Personal Web Server (PWS) can be used to develop server-side applications very easily. Unfortunately, it can only handle 10 Web connections from client computers. Each connection forms a communication socket between the

server and the client computer. Yet, for a development environment, it gives us the type of control and performance that can be expected from a more enterprise-driven server like Microsoft’s Internet Information Server (IIS) or the Apache Web Server. Once the Web site is developed using PWS, a developer simply moves the Web pages, images, databases, and other components to a production server like IIS or Apache that can be accessed by anyone on the Internet.

PWS allows the developer to establish root directories and virtual directories needed to house a Web site. Figure 2 illustrates the main window that points to the root directory “C:\DAVE.” The root directory is the actual starting position on the Web server for the Web site. It can be changed to any directory on the server using the PWS manager’s “Advance Menu.” The advance menu can also be used to establish virtual directories that can hold executable files, databases, and other components that are often linked to Web pages.

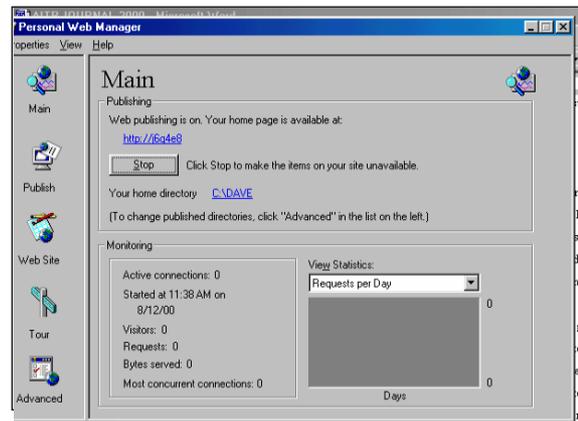


Figure 2. Personal Web Server – Manager

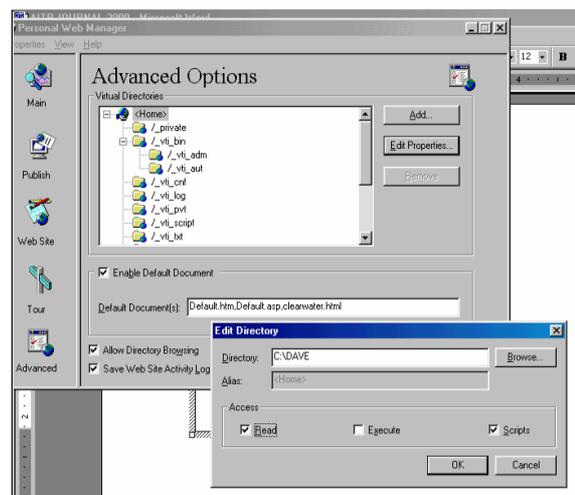


Figure 3. PWS Advanced Options

Figure 3 demonstrates the use of the advance menu to add (“ADD”) virtual directories or change (“EDIT”) the root directory. The PWS manager default document can point to the index page or the main page within the root directory; these are the pages first seen by the user when they type the URL address within their browsers. Using the Snap-In tool within IIS, the user can also designate root directories, virtual directories, and document settings.

The PWS manager allows the developer to control access to directories connected to the Web site in terms of “READ,” “EXECUTE,” or “SCRIPT.” The “READ” option permits the user to download Web pages, images, or any other components on the Web pages that reside in the current directory. The “EXECUTE” option permits the user to execute any CGI programs within this directory. Finally, the “SCRIPT” option allows the user to execute server-side scripts within this directory. These privileges are important because they allow the Web developer to control the directories where Web pages, images, databases, and programs are stored. This setup establishes an environment that can be used to train IS professionals.

### 3. Database Design

Database design is essential for developing any Web site that requires tables of information to update and retrieve data. This topic is often presented in earlier courses in an IS curriculum; but could be presented as part of a comprehensive Web site development course. The discussion should focus on relational database design, since over 95% of database access on the Internet is relational databases. Relational design involves the normalization process, which can help IS students understand possible relationships between tables of information. The normalization process is beyond the scope of this paper and should be reviewed if necessary, but it will produce easily maintainable and accessible data tables. The relationship diagram is an important tool generated by this process; Figure 4 provides an example of a relationship diagram.

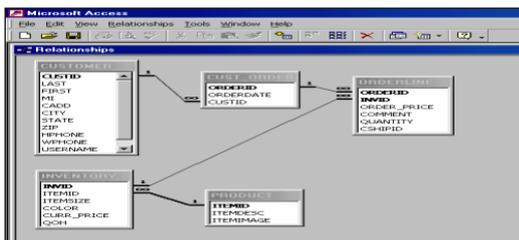


Figure 4. Relationship Diagram

Once the relationship diagram is generated, ACCESS or Oracle (ACCESS is more readily available on student’s computers) can be used to design each table: to identify the

data fields, the characteristics of each field (text, number, size, validation rules, etc.), primary keys, and foreign keys. ACCESS is a personal database which can be used in a development environment to gain the knowledge and experience of relational databases. Yet, Oracle would be a more appropriate relational database for the client-server environment of the Internet. SQL commands will work with either database allowing ACCESS to be a viable alternative to Oracle in the development process.

The next step is to load the tables with sample information. To expedite the loading process, the instructor can provide the data for copying into the tables.

### 3.1 Structured Query Language (SQL)

The database will reside on the server-side computer. The Web pages that will access the database and process the resulting information will also be stored on the server-side computer. When a user requests a Web page that has some server-side processing, the server-side scripts or CGI program is executed before the page is sent to the client’s computer. Structured Query Language (SQL) is used within the server-side scripts or CGI program to access the database. Specifically, embedded SQL commands access and update the tables within the database. Internet developers should have a good working knowledge of SQL statements.

By using the Query option within ACCESS, the IS developer can easily generate from the most basic to the most complex SQL statements. Figure 6 is an example of a standard JOIN statement between the “Customer” and the “Cust\_Order” tables. The resulting table is a combination of information from two tables for customer number 5.

```
SELECT FIRST, MI, LAST, CADD, CITY, ZIP, HPHONE,
ORDERID, ORDERDATE
FROM CUSTOMER, CUST_ORDER
WHERE
CUSTOMER.CUSTID = CUST_ORDER.CUSTID
AND
CUSTOMER.CUSTID =5;
```

FIRST	MI	LAST	CADD	CITY	ZIP	HPHONE	ORDERID	ORDERDATE
Sally	T	Flag	891Willis	Normal	61790	(309) 555-2331	5	11/1/00
Sally	T	Flag	891Willis	Normal	61790	(309) 555-2331	6	11/1/00

Figure 6. Join SQL Statement

The “JOIN” statement reflects the power of relational databases. SQL can take information from more than one table from one query. The relationship diagram helps the developer trace the connections between tables using the “WHERE” portion of the SQL statement.

Notice the connection between the customer table and customer order table is customer ID. The “WHERE” portion of the SQL statement can shape this relationship with an “equal to “ condition (CUSTOMER.CUSTID=UST\_ORDER.CUSTID). ACCESS thus provides a mechanism to build a solid insight into relational design and database processing.

#### 4. Web Site Development

Generating a sound Web Site Plan will prevent confusion and add continuity to the development process. The focus of the Web Site Plan should reflect the logical information flow between the client and the server computers. The logical flow should be developed into a Web Site Flowchart. Figure 7 provides an example of a Web Site Flowchart.

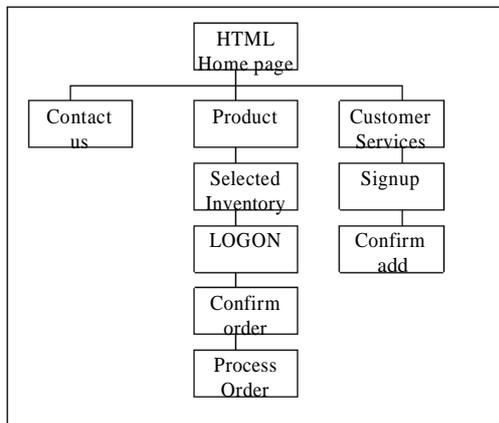


Figure 7. Web Site Flowchart

Once the Web Site Flowchart is developed, the developer can start to visualize the information needed for each page on the diagram. This information might be needed to access databases, to pass to subsequent pages, to be placed in cookie files, or simply to add aesthetic value to the web page. For example, the “Selected Inventory” page in Figure 8 requires the image of the selected product along with its sizes, colors, and availability. This information is taken from two tables: (1) product and (2) inventory. The user provides the quantity and the selection of an item. According to the Web Site Plan, the “Selected Inventory” page will pass inventory item and quantity to the “LOGON” page so that the information can be passed along to the “Order Confirmation” page. The latter page will calculate shipping, taxes, and totals. Figure 8 shows the portion of the Web Site Plan involving this process. The complete Web Site Plan will entail the complete development process.

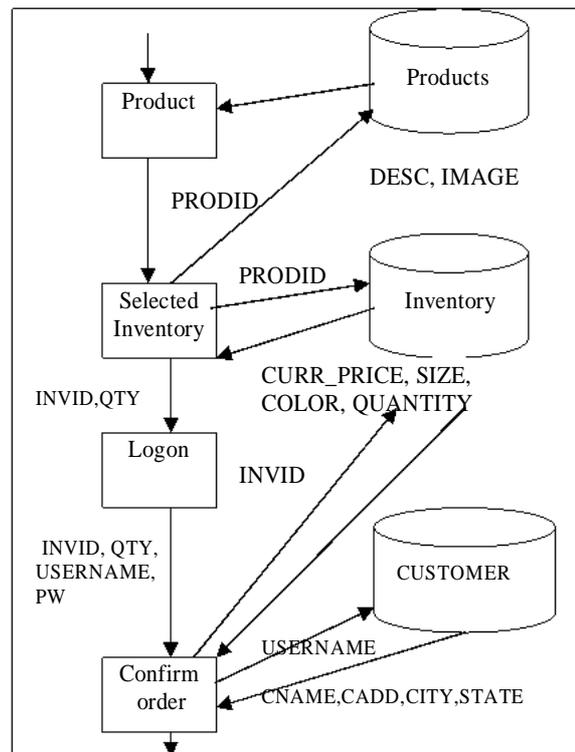


Figure 8. Partial Web Site Plan

#### 4.1 Coding

The Web Site Plan provides the more detail information needed to process data and display this information on a Web page. Yet, the Web pages will also include the images, logos, background colors, style sheets, animation, and other design components that will bring the Web pages to life for the user. A layout sheet is a good tool for displaying how colors, images, animation, frames, tables, and scripts should interact and coordinate with each other to present a logical, consistent, well-constructed Web page.

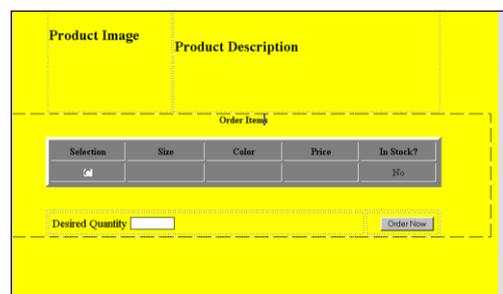


Figure 9. Web Page Layout Sheet

Figure 9 illustrates an abbreviated sample of a layout sheet with its various components. By subdividing the various components of the Web page into the heading that is read first by a browser and the body where the action takes place or originates, the developer can place server-side scripts in strategic locations where the results can be displayed on the Web page. For example, product's image and description from the product table must be retrieved before the individual sizes and colors from the inventory table. Both tools serve to formulate the Web page and guide the coding process.

## 4.2 Active Server Pages (ASP)

The title bar on the Web page will carry the description of the product. The developer can access the product table and retrieve this description using Active Server Scripts (ASP) that relies on an Open Database Connectivity (ODBC). ASP uses a server object that can be opened and executed using embedded SQL statements.

```

Setup Server Object:
<% Set ConDW = Server.CreateObject("ADODB.Connection")%>
Open Server Object:
<% Dim DBPath, DrvType %>
<% DBPath = Server.MapPath("customer.mdb") %>
<% DrvType = "Driver={Microsoft Access Driver (*.mdb)};" &
    "DBQ=" & DBPath %>
<% Set connCW = Server.CreateObject("ADODB.Connection") %>
<% connCW.Open DrvType %>
Execute Server Object with query string:
<% queryString = "SELECT proddesc, prodimage " & _
    "FROM product " & _
    "WHERE prodid = " & intProdID %>
<% Set rsProduct = conDW.Execute(queryString) %>

```

Figure 10. Server Object Sequence

```

<!-- create a query string to retrieve item and image -->
<% queryString = "SELECT * " & _
    "FROM inventory " & _
    "WHERE prodid = " & intProdID %>
<% Set rsItem = conDW.Execute(queryString) %>
<% intloopCount = 0 %>
<% Do While Not rsItem.EOF %>
<!-- set first button checked -->
<TR><TD ALIGN=CENTER width="112"><INPUT
TYPE=RADIO
    NAME=invid VALUE=<% =rsItem("INVID")
%>></TD>
<TD ALIGN=CENTER width="117"><% =rsItem("ITEMSIZE")
%></TD>
<TD ALIGN=CENTER width="114"><% =rsItem("COLOR")
%></TD>
<TD ALIGN=CENTER width="113"><% =rsItem("CURR PRICE")

```

Figure 11. Displaying Retrieved Items

Figure 10 illustrates the sequence of commands that retrieves records from a table within a database. Notice that the embedded SQL statements are placed in a string variable called "queryString" and that ASP scripts are surrounded by the "<%>" and "<%>" delimiters. The Server

Object executes this query string. This pattern can be replicated for each Web page that accesses a database using ASP scripts.

Figure 11 demonstrates a SQL execution where the result is a table of records. These records are placed in a record set called rsProduct. The developer can display these records with ASP scripts (<% =rsProduct(PRODDESC) %>) using a looping process. Figure 11 demonstrates the looping process that can be coded to display records coming from the record set.

Passing information between Web pages is essential when subsequent Web pages require the information or simply needs to pass it to the next Web page. As indicated by the Web Site Plan, some Web pages will have to use or pass information from a previous Web page. Figure 12 shows how product ID (prodid) is sent to the Order Page using the URL method. The Order Web Page receives the variable using the "Request.QueryString" method. Once the product ID is received, the embedded SQL statement (queryString) can use it to retrieve a record from the product table (See Figure 12). Notice that the name of Web pages with ASP scripts has the ".asp" extension.

```

Send Product Page:
<A href="order.asp?prodid=<% =rsProd("PRODID") %>"
  <% =rsProd("PRODDESC") %></A></td>
Receive Order Page
<% intProdID = Request.QueryString("prodid") %>

```

Figure 12. Passing URL Variables

Often variables must be sent to another Web page using the "Form" method. The sending page will have a form with variables. This form can be passed to another Web page along with its variables. The receiving page will use the "Request.Form" method to receive the variables.

```

Form Data Passed:
<FORM NAME=FrmlLogin METHOD="POST"
ACTION="ordersconfirm.asp">
<INPUT TYPE=HIDDEN NAME=invid
    VALUE=<% =Request.QueryString("invid") %>>
<INPUT TYPE=HIDDEN NAME=quantity
    VALUE=<% =Request.QueryString("quantity") %>>
<TABLE WIDTH=60%>
<TR><TD WIDTH=50% ALIGN=RIGHT>User ID:</TD>
<TD WIDTH=50% ALIGN=LEFT><INPUT TYPE=TEXT
    SIZE=15 NAME=username></TD></TR>
<TR><TD ALIGN=RIGHT>Password:&nbsp;</TD>
<TD ALIGN=LEFT><INPUT TYPE=PASSWORD SIZE=15
    NAME=password></TD></TR>
Form Data Received:
<% passInvid = Request.Form("invid") %>
<% passQuantity = Request.Form("quantity") %>
<% passUsername = Request.Form("username") %>
<% passPassword = Request.Form("password") %>

```

Figure 13. Form Data Pass

Figure 13 shows how form data between the Logon Web page and the Confirm Order Web page is sent and received. The Web Site Plan along with the Layout Sheets should show the variables included with forms and the variables to be passed as URL data. Figure 13 shows that the Logon Web page receives inventory ID (invid) and quantity from the Order Web page. The sending page places these values as hidden variables within the form called "frmlogin." This form also receives the username and password from the user. The Logon Web page will pass to the Confirm Order Web page four form variables as indicated by the Web Site Plan.

### 4.3 Testing/Debugging

Testing and debugging generally occurs at four levels: (1) the code level, (2) the page level, (3) the unit level, and (4) the system level. The code level focuses on segments of code that accomplish a specific task like accessing specific records from a database, displaying images, or linking to other pages. At this level display statements can be used to evaluate the status of variables at a specific point in the execution of the Web page or to identify the extent of execution of the Web page. Figure 14 identifies some typical display statements for a Web page with ASP script variables and some alert statements for JavaScript variables. The display statements will help the developer track the execution of the program and the value of the variables during execution. This technique is very beneficial when debugging a Web page.

```

ASP Display Method:
Quantity = <% =passquantity %>
Password = <% =passpassword %>
Javascrpting ALERT method:
<SCRIPT LANGUAGE="JavaScript">
function checkit(frmOrderItems)
{ alert("within checkit")
var strUserName, strInvid, strQuantity,
strURLParams
alert("before loop")

```

Figure 14. Testing/Debugging Statements

The page level testing looks at how all of the components on the Web page work together to achieve an overall purpose. Figure 15 illustrates a simple Test Plan that can determine the accuracy and success of all the actions involved on one Web page. Notice that the expected and actual results generate remarks that help the developer solve any differences between them.

Unit level testing involves identifying a complete process to accomplish a given task. Customer ordering involves more than just one Web page, but the ordering process is one unit or transaction. The Test Plan should identify all possible logical outcomes associated with the ordering process. Each of these outcomes should be tested

in order to verify that the Web site handles these situations correctly. Any discrepancies should be noted in the remark column and addressed with the appropriate actions. Other possible transactions or units can include customer signup, customer services, and customer feedback. Of course, the number of units depends on the size of the organization and the Internet services that it provides.

Item	Expected Result	Actual Result	Remarks
1. Initial load	Home Page	Home Page	
2. Image Load	5 Images	4 of 5	Logo failed
3. Receive Pass	Selected	Selected	
ProdID product			
4. Link to Program	Pgm Page	Pgm Page	
5. Retrieved Product			
Data	Description	No Values	SQL failed
6. Date Retrieved	Current Date	Current Date	
7. Calculate total	Total Sales	Wrong Total	Calc. not correct
8. Text Spelling	Correct Sp	Correct Sp	

Figure 15. Test Plan

Finally, testing and debugging at the system level focuses on navigating amongst all the various units on the Web site including ordering, customer services, and administration. A Test Plan at this level will list all the possible units on the Web site, which are often listed on the index or main page as links to other Web pages. The expected and actual results consist of the appearance of the correct Web page for each hyperlink to include both forward and backward links. Any differences between expected and actual results should be noted and placed as an appropriate remark on the Test Plan. These remarks help the developer rectify any user navigation problems.

### 4.4 Documentation

The final stage in the development process is documentation. Documentation is used to provide a basis for review and to update the Web site. Web sites are dynamic because they change with technology and market conditions. The organizations must be able to this challenge of a rapidly changing environment. Establishing a documentation standard for the organization will provide continuity and consistency in the development process. The documentation becomes the "road map" during the analysis process that will expedite future enhancements and improvements of the Web site. Figure 16 shows an abbreviated set of documentation for a Web Site. The

documentation can include test plans to verify the Web site's performance.

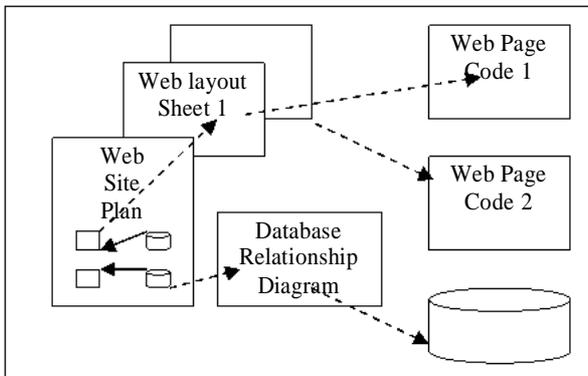


Figure 16. Web Site Documentation

Internet will dramatically increase over the next few years, and with this escalating demand for Internet-based commerce, organizations are expecting to recruit IS personnel who can develop applications on the Internet. With limited resources, academic institutions have been revamping their curriculum to accommodate the growth of the Internet as well as to maintain the more traditional IS core curriculum. By utilizing readily available computer hardware and software, academic institutions can provide an effective and active Internet learning environment.

## References

- [1] Cashman, Shelly, and Quasney, Dorin. JavaScript: Complete Concepts and Techniques. Cambridge, MA. Course Technology, 2000.
- [2] V. Grover and J. Teng, "E-Commerce and the Information Market: Breeding the New Infomediaries," Communications of the ACM, Vol.44, No.4, 2001, pp.79-87
- [3] Morneau, Keith, and Batistick. Active Server Pages. Cambridge, MA. Course Technology, 2001.
- [4] Morrison, Mike. and Morrison, Joline. Database-Driven. Cambridge, MA. Course Technology, 2001.
- [5] Schneider, Gary P. and Perry, James T. Electronic Commerce. Cambridge, MA. Course Technology, 2001.

# E-Business: Customer Acceptance

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## Abstract

Numerous business-to-consumer (B2C) Internet enterprises have failed over the past few years. Many reasons have been proposed for the failures of these e-businesses. This empirical study examines one possible reason for lack of success of B2C, the extent to which this online shopping opportunity actually alters the traditional purchasing behavior of the retail consumer. Based on accepted marketing theory, the findings indicate more retail shoppers use the Internet for information gathering than for actual purchasing. Clearly, Internet buyers have choices in their purchasing decisions.

## 1. Introduction

In the past few years, numerous business-to-customer (B2C) e-commerce startups have been unsuccessful. The reasons for this lack of success have been debated extensively. In the popular press much attention has been directed at many proposed contributing factors to e-business (B2C) failures. These factors include, but are not limited to: evaporation of the market for initial public offerings, the failure of consumers to adopt online buying practices, ill conceived business plans, flawed pricing structures, the ability of consumers to better detect price discrepancies, limited or no customer service, security and trust issues, the cost of attracting customers, and general lack of old-fashioned merchandising [1] [2] [3] [5] [9] [10] [12]. Clearly, much of the problem with these failures was the hype associated with the Web. Many entrepreneurs thought that setting-up a Web Site would attract customers by the thousands to buy their products or services. The reality is that there is no substitute for sound management and marketing practices.

Companies such as Amazon.com and eBay have held on during the e-commerce shakeout. Amazon and eBay (an online book seller and a person-to-person online auction, respectively) had the advantage of being first movers, but both have continually changed their sites to offer their customers what they want. For example, Amazon.com has used software to hone in on customer buying patterns. eBay uses a rating system for to buyers to rate sellers on quality of merchandise, speed of delivery, and other factors [12].

E-business entrepreneurs knew that the Internet would benefit consumers by allowing them to easily compare prices among competing retailers to find the

lowest price for purchase. However, making effective use of online competitive price information, and actually purchasing online has been more difficult for consumers than online retailers originally thought [5]. While this online price comparison opportunity is available to Internet users and may be helpful, the question that remains is to what extent this online shopping opportunity actually alters the traditional purchasing behavior of the Internet consumer.

As noted above, the popular press has repeatedly reported on the recent e-business failures. However, these reports do not have a theoretical foundation, and are not based on a scientific study. This research project explores the actual purchasing practices of Internet users. In this study, based on marketing theory, we analyze the online shopping practices of Internet users to discern how they utilize the Internet in their actual purchasing process. Based on these results, we offer some possible explanations of their buying behavior as well as suggestions for future research.

## 2. Background

Over the years, marketing research has developed a theoretical model for describing consumer decision making in the purchasing decision process. It consists of five major phases as follows: (1) need identification, (2) information search, (3) alternatives evaluation, (4) purchase and delivery, and (5) after-purchase evaluation [8]. This model offers a generic overview of the consumer's decision making process, and is not always followed by a consumer, nor is it a linear process for the consumer.

Recently, this consumer decision model was extended to web purchasing, in the form of a framework called Consumer Decision Support System [11]. While this framework addresses all five of the decision making phases, our research focuses on the use of the Internet in the second phase, the information search, and the fourth phase, purchase and delivery.

The second stage, information search, can occur internally by recalling information stored in memory, or it can occur externally. The external information search for an Internet user can be greatly enhanced by the Web, which is fast, readily accessible, and essentially free. Internet databases and product search engines can be very beneficial at this stage.

The Web consumer's search will generate a set of preferred alternatives, which will be compared and

evaluated to derive the fourth stage, the ultimate purchase decision. However, the alternatives include many buying options, only one of which is purchasing online. Since each phase of the decision making model is independent, the Internet user may purchase the product either online or offline, even after using the Web to gather information on product(s). In fact, the purchase decision may actually favor a traditional retailer, since utilizing an online retailer often involves uncertainty as to credit card privacy, timely arrival of the product, satisfactory return policy, and even accurate vendor pricing. This study collects data on how online shoppers use the Web in the second stage, information search, and whether or not they have actually purchased goods or services on the Web, the fourth stage.

### 3. Overview of the Study

The purpose of this study is to determine the buying practices of Internet users. This study is an extension of a past study done in 2000 using students as subjects [6]. At the suggestion of reviewers and discussants, we extended the study to include a cross section of shoppers.

In this study, a sample of 137 consumers from an American shopping mall was chosen from a typical American city. Shoppers were chosen at random at times and on days viewed by the mall marketing manager as appropriate for conducting the survey. Shoppers were asked to fill-out a questionnaire (Table 1) and assured anonymity in filling out the survey. The questionnaire was validated with a test group before giving the instrument to the one-hundred and thirty-seven consumers used in the survey.

**Table 1: Questions and Responses**

Question	Responses
1. Please indicate your sex.	A. Male B. Female
2. Please indicate your age.	A. 18-26, B. 27-31, C. 32-36, D. 37-40, E. Over 40
3. Please indicate your marital status.	A. Unmarried, B. Married
4. Indicate the number of hours per week you are currently employed.	A. None B. 1 to 15 C. 16 to 25 D. 26 to 40 E. Full time
5. Highest level of education attained.	A. Some high school B. High school graduate C. Some college D. College graduate E. Graduate work
6. Total approximate amount of family's annual income.	A. \$10,000 or less B. \$10,000 to \$25,000 C. \$25,000 to \$40,000 D. \$40,000 to \$50,000 E. More than \$50,000
7. Use of the Internet for personal communication	A. Frequently B. Occasionally

purposes.	C. Seldom D. Never
8. Use of Internet for business purposes.	A. Frequently B. Occasionally C. Seldom D. Never
9. Use of Internet for pricing purposes.	A. Frequently B. Occasionally C. Seldom D. Never
10. Use of the Internet for purchasing purposes.	A. Frequently B. Occasionally C. Seldom D. Never

The first three questions are used to collect demographic data on the users in this study. This will allow us to compare the demographics of our sample with the demographics of previous studies on Internet users. The next three questions (4, 5, & 6) are used to determine buying potential through employment status, education level, and income. The next two questions (7 & 8) are used to determine personal and business use of the Internet by shoppers. The next question (9) is used to determine how the shopper uses the Internet in determining information about products or services, the second phase of the consumer decision model. The last question (10) serves to determine whether users purchased a product or service over the Internet, the fourth stage of the consumer decision model.

### 4. Findings

The demographics of our sample are distributed as follows. In our sample, approximately 39% were male and 61% were female, approximately 36% were between 18 and 26 years old, 33% between 27 and 40, and the users over 40 years old accounted for about 31%. Approximately 52% were married, 45% were not married.

With the exception of gender, the demographics of this study fit very well with those of the typical Internet consumer as reported by the latest Gvu Center Survey at Georgia Institute of Technology [4] in 1998. The Gvu Survey indicates that most users are between the ages of 16 and 40 (approximately 60%). Most of the users in this study are between the ages of 18 and 40 approximately 70%. In the Gvu Survey 64% were male and 36% female. In this study, there are approximately 61% women and 39% men participating. Our population consisted of a cross section of American shoppers (72%) had some college and as indicated by the 1998 Gvu Survey almost 90% of Internet users had at least some college. In the Gvu study, approximately half of the respondents were married and half were not. In this study, 55% were married and 45% were not.

Time spent on the Internet by users for personal and business use varied. Approximately 86% of the shoppers in the study used the Internet for personal use. For personal use purposes, approximately 54% use the Internet frequently, 20% use the Internet occasionally, 12% seldom use the Internet, and 14% never use the Internet for personal use.

Approximately, 66% use the Internet for business purposes. Frequent use for business purposes is 27%, occasional use is 20%, seldom use is 19%, and 34% did not use the Internet for business purposes.

We analyzed aspects of the consumer decision model. The results of this study indicate Internet consumer application of Phases 2 and 4 of the five-phase consumer decision model [8]: 1. Need identification, 2. Information search, 3. Alternatives evaluation 4. Purchase and delivery, 5. After-purchase evaluation.

Over 71% of the users in this study use the Internet to gather information (Phase 2) on products or services for pricing, but only 57% actually make the purchase (Phase 4) on the Internet. As stated earlier, the use of the Internet offers an online price and product/service comparison opportunity, but this online shopping opportunity only partially alters the purchasing behavior of the Internet consumer as seen by the 14% who do not purchase (Phase 4) on the Internet.

#### 4. Discussion

This study confirms that Internet users have choices in their purchase decision. It demonstrates that many of them use the Web to access information in order to compare products and services. However, it appears that fewer of these same Internet users have broken away from their traditional purchasing habits to actually use the Web to buy products and services. While most of these Internet users find the Web helpful in the information search phase of the purchase decision, fewer apparently are comfortable enough on the Web to actually consummate their purchase online.

The findings of our study are consistent with the e-commerce concepts proposed recently by noted IT author Peter Keen (2001) [7]. He states that the central problem that the Internet poses for shopping online requires that we trust people and organizations in which we have no experience. We are interacting with organizations, which we have never seen, whose identity we may not be able to validate. And all of this is occurring in situations where misunderstandings occur frequently and are difficult to correct. Modern, online trust involves trust relationships with entities we have never met face-to-face, where the proverbial handshake is absent.

So, how does an e-commerce firm overcome this trust obstacle? In order for the Internet to become a viable and profitable media, online companies must heed Keen's advice and build trust in their relationship with the customer. One possible alternative is to look to a successful e-commerce firm like Amazon.com, which was mentioned above. Amazon.com ensures that every customer interaction is a two-way dialog, that customer questions are fully answered, that customer problems are immediately handled, and that the customer is kept informed of their order status. Over time that attention to the customer's concerns builds a trust relationship that has translated to an 80% repeat business rate for Amazon.com [7]. E-commerce firms must offer more than products that customers want. They must also build

customer trust with policies that ensure convenience, credit, security and easy returns. E-commerce firms must take the fear out of the purchasing transaction process for their customers.

#### 5. Conclusions and Suggestions for Future Research

This study extends previous exploratory research examining consumer buying practices on the Internet. The previous study [6] involved the Internet buying behavior of American University students. The current study extends this research to American retail shoppers chosen at random in a retail shopping mall.

The findings of the current study indicate that while 71% of the respondents use the Internet for information search in the purchasing decision process, whereas only 57% of those surveyed, have actually purchased products or services over the Internet. The findings are consistent with the previous study using students as subjects. Customers do have choices in the purchasing process and will buy goods and services using the approach that satisfies their need for trust at the time of purchase.

One advantage of this study over the previous study was that a better cross section of shoppers was surveyed, as opposed to the last study where only student subjects were used. The study could be extended to include questions on ethnicity of shoppers and types of products and services purchased. A more global perspective on purchasing could be achieved using an international sample.

#### References

- [1] Barta, P. "On the House," A Report on E-Commerce, *The Wall Street Journal*, Feb. 12, 2001, p. R 16.
- [2] Caruana, L. "Year of the Dotcom Failures," *The Australian*, Dec. 23, 2000.
- [3] Gomes, L. "Fix It and They Will Come," A Report on E-Commerce, *The Wall Street Journal*, Feb. 12, 2001, p. R4.
- [4] GVU Center, College of Computing, Georgia Institute of Technology, *GVU Tenth WWW User Survey*, Oct. 1998, [http://www.cc.gatech.edu/gvu/user\\_surveys/](http://www.cc.gatech.edu/gvu/user_surveys/)
- [5] Hamilton, D.P. "The Price Isn't Right," A Report on E-Commerce, *The Wall Street Journal*, Feb. 12, 2001, p. R8.
- [6] Jaska, P. and Hogan, P. "Dotcom Failures: Customers Click Cancel," *2001 Proceedings*, Annual Meeting of the Decision Sciences Institute, San Francisco
- [7] Keen, P. "Welcome to the Trust Economy," *Intelligent Enterprises*, Vol. 4, no. 3, pp. 36-49.
- [8] Kotler, P. and Armstrong G. *Principles of Marketing*, Prentice Hall, N.J., 1999.
- [9] McWilliams, G. "People Who Need People," A Report on E-Commerce, *The Wall Street Journal*, Feb. 12, 2001, p. R20.
- [10] Nelson, E. "On the Right Scent," A Report on E-Commerce, *The Wall Street Journal*, Feb. 12, 2001, p. R18.
- [11] O'Keefe, R. M. and McEachern, T. "Web-Based Customer Decision Support System," *Communication of the ACM*, March 1998.
- [12] Wingfield, N. "The Giants," A Report on E-Commerce, *The Wall Street Journal*, Feb. 12, 2001, p. R6.

# A Quality of Service Framework for Internet Share Trading

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## Abstract

The recent Quality of Service (QoS) architecture proposed by the Internet Engineering Task Force (IETF) enables a set of new network services providing possible solutions to improve the quality of the Internet-based services. The interest of this research is to find a customizable QoS network solution for the Internet based share trading business by deploying these QoS architectures in order to address the quality issues in the Internet Share Trading Business. The construction of the QoS theoretical framework begins with the identification of the Internet service capabilities required by the Internet share trading business through a case study. The appropriate QoS architectural design is selected through matching the existing QoS architectures with the identified service capabilities. The QoS technological strategies and QoS capabilities are thus derived from the selected QoS architectural design. Additionally, the effectiveness of the proposed QoS architectural design is evaluated against the current implementation by using computer simulation.

## 1. Introduction

With the increase in Internet service availability that occurred during the 1990s, the Internet has become more frequently integrated into business practices. It has lowered worldwide communications costs for individuals and businesses and opened up unprecedented opportunities and challenges for conducting business. This integration has also brought new threats to businesses relying on the Internet due to such issues as the varying quality of Internet service. Internet share trading business is a typical example of an online business affected by this issue.

The Internet related quality issues raised by the Internet share trading business have been regularly reported in the news, and discussed in academic research. Problem identified to date have included slow response times [20] [22], service unavailability during busy periods [7] [11], reliability problems [11] [21], and in the worst case, service being completely brought down by security attacks [4] [15]. These problems have also occurred to big industry players such as E\*trade and Charles Schwab. Hence enhancing the quality of the

Internet service available to business users is a critical issue in the industry.

The recent Quality of Service (QoS) architecture proposed by the Internet Engineering Task Force (IETF) enables a set of new Internet network services providing possible solutions to improve the quality of the Internet based services. However, the existing principle for the development of QoS solutions takes a technological focus without addressing the quality of service requirements of the business.

The interest of this paper is to find a customizable QoS network solution for the Internet based share trading business. The following research questions are specifically addressed in this paper.

- How does current IP network provide service support for Internet share trading businesses?
- Why does the current IP network fail to provide quality of service support for Internet share trading?
- How can Internet share trading business apply IP QoS techniques to solve the service quality issues in Internet share trading?

The structure of this paper is: first, a literature study is conducted to review the relevant research issues including quality of the Internet share trading business and IETF QoS architectures; Secondly, the research methodology is presented and the research framework is introduced; Thirdly, a case study is outlined to identify and specify the service capabilities required by the Internet share trading business; Fourthly the proposed QoS theoretical framework including technological strategies (or, QoS capabilities) and architectural design is discussed; Lastly, a performance evaluation for the proposed QoS solution by using computer simulation is reviewed.

## 2. Literature Study

### 2.1 Quality of the Internet Share Trading Business

In the Internet share trading business model, the Internet has been an integral part of the business. Quality of the Internet service has been emerged as a critical factor for evaluating the overall business performance.

The Internet has enabled service channels for the business which allow online investors located at one end of the channel to access the share trading services provided by the brokerages located at the other end. This new service channel enhances the interaction between brokerages firm and online investors, totally eliminating the person-to-person contact required by traditional share trading. Hence the quality of the Internet service required by the business is characterized as end-to-end service assurance.

Currently many surveys and case studies have evaluated quality of Internet share trading business, identifying Internet-related factors of timeliness, reliability, availability and security as important for online investors to monitor. These four factors can be used to described business-required end-to-end service assurance (Figure 1).

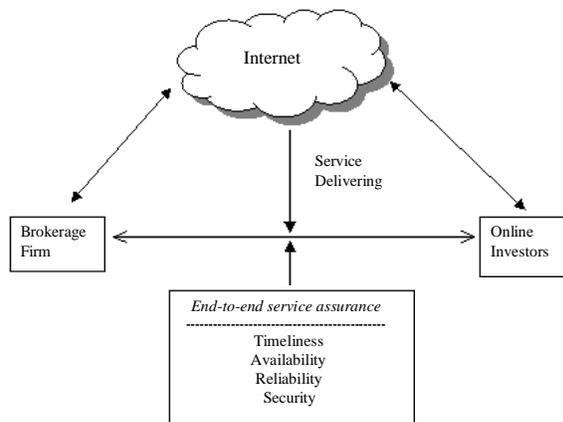


Figure 1. Quality of the Internet Share Trading Business

### 2.1.1 Timeliness

Timeliness is a critical attribute affecting the service quality of the Internet share trading business [14] [19]. Timeliness is also referred to as responsiveness of the services [8].

Due to the fact that share prices are subject to change, online investing services need to be delivered in a real-time manner. Even a second's delay in share transactions, may cause real money loss for the investors. Online investors expect fast responses from the system so that their share trading transactions can be processed rapidly. Currently there is no industry regulation requiring a transaction to be executed within a set period of time [19], although increasing timeliness in the service does help firms attract more businesses.

### 2.1.2 Reliability

Reliability, one of the fundamental requirements urged by business refers to consistency of performance [8] [23] Internet share trading business requires consistent levels of Internet service support. For example, in the US, the

Securities and Exchange Commission (SEC) understands an absolute guarantee of service is difficult to implement in the Internet share trading, but it may require online brokerage firms to conform to certain statistical standards of service proactively.

Another sense of reliability refers to the accuracy of the service [17]. Internet share trading businesses should have the ability to detect and rectify any faults in order to ensure reliability of the service.

### 2.1.3 Availability

Availability is another important factor in the Internet share trading business [14] [25]. Online service must be accessible at all times to businesses, especially during the peak trading hours.

NASF Regulations remind brokerage firms of their obligations under SEC staff legal bulletin No. 8 to ensure that they have adequate capability to handle high volume or high volatility trading days [14].

### 2.1.4 Security

Security is one of the greatest concerns for Internet share trading business as the entire operations are monetary and information-based transactions [12] [4] suggests that a robust security solution for transaction processing should satisfy certain security requirements including confidentiality, authentication, data integrity and availability, all of which need to be met by the Internet services as well as the whole business.

Recent news reports continually disclose these quality issues as well as the many complaints raised regarding these issues. The complaints include slow performance [20] [22], system unavailability [11], reliability problems [11] [21], and security attacks bringing down the system [15]. These indicate that the current Internet quality does not provide the satisfactory level of service support for the business in term of these attributes such as timeliness, availability, reliability and security.

## 2.2 IETF QoS Architectures

Technically, the Internet Protocol (IP) plays a key role in facilitating Internet connections. The Internet is so called the network of IP networks. The current IP network applies end-to-end design principles [18]. It can only support one class of service: *best effort*. Hence the main drawback of the IP network is that it makes no guarantee about when data will arrive, how much can and cannot be delivered, and how reliably delivery will be. And it has no security feature as well.

Recent QoS architectures proposed by the Internet Engineering Task Force (IETF) such as Integrated Services (IntServ), Differentiated Services (DiffServ) and Multiprotocol Switching (MPLS) have opened up the new possibility to build new capacities of the network service which can improve the service quality of the

Internet network service. In the following sections service features of three QoS architectures are introduced.

### 2.2.1 IntServ

The key service feature of IntServ is to pre-reserve the required network resource in terms of user's requirements. In this way, IntServ can provide a certain level of resource assurance to meet the user's QoS requirements such as strict delays required by real time applications.

In comparison with the current IP network service, IntServ has enforced the following QoS features so as to enhance the service quality of the existing IP network services

#### □ □ Resource Reservation

Resource reservation is the key QoS feature enforced by IntServ. With this resource reservation technique, IntServ can provide resource assurance for critical applications with absolute delay requirements.

#### □ □ Admission Control

IntServ enforces admission control over the reservation path in order to limit the access by non-critical applications and to guarantee the network resource for critical applications.

#### □ □ End-to-end control

IntServ uses end-to-end signaling protocol such as RSVP to set up the reservation path, so it thus enforces an end-to-end control function and can also dynamically respond to the changing traffic conditions in the network.

### 2.2.2 DiffServ

The DiffServ architecture has provided an alternative resource allocation scheme in order to enforce service differentiation [5]. Network resources are allocated to traffic streams by a service provisioning which mainly includes classifying and policing the traffic upon entry into a DiffServ network and forwarding that traffic within the network. Hence, DiffServ can provide relative service guarantee to meet different user's QoS requirements.

The main QoS feature of DiffServ is that it can enable traffic prioritization which prioritizes the network service for use by different types of businesses and different users. Since this resource prioritization function is mainly implemented at the point of traffic aggregation, it can be referred to as per-hop based resource prioritization [2].

### 2.2.3 MPLS

MPLS was originally developed as an alternative approach to support IP over ATM. It allows IP routing protocols to take direct control over ATM switches

The key technique of MPLS is known as label switching, which uses a short fixed-length label encoded into the packet header and used for packet forwarding. All the labels assigned by end points construct a Label Switched Path (LSP). By using the label switching

forwarding engine, there is no need to perform routing look-ups on each node over the LSP when the data packet passes through. Thus, the MPLS network addresses the scalability issue and can support a large network.

An MPLS network needs a LDP – a signaling protocol to set up LSPs. And the LSP setup needs the routing selection to determine the next hop information. Two routing approaches can be employed for the LSP setup: one is hop-by-hop routing, still used by the current IP network and the other is explicit routing.

CR-LDP, recently developed signaling protocol uses constraint-based routing and can establish an explicit route also referred to as a constraint-based route or CR-LSP. The CR-LDP allows resources to be preempted or reserved for explicit routes based on relevant traffic parameters such as peak data rate (PDR), committed data rate (CDR), peak burst size (PBS) and committed burst size (CBS) [1].

As a consequence MPLS functions that go beyond the routing tasks can fundamentally enhance the current IP network for both features and services. It has enforced the following QoS features:

#### □ □ Performance Optimization

Performance optimization can be achieved by way of traffic engineering [26, p. 10]. Traffic engineering is the process of controlling how traffic flows through a network to optimize resource utilization and network performance [6].

MPLS-based traffic engineering allows traffic to use multiple paths, rather than the single optimal path used by conventional-based networks. MPLS supports traffic engineering through the deployment of constraint based routing. The deployment of constraint-based routing not only provides route but can also meet QoS requirements [13].

#### □ □ MPLS based Tunneling

MPLS can enable tunneling encapsulation by encoding a label outside the IP header. This is one of the ways to set up tunneling. The other way to enable MPLS-based tunneling is that MPLS allows multiple labels to be encoded into a packet to form a label stack. Such nested LSPs can create a multilevel hierarchy where multiple LSPs can be aggregated into one LSP tunnel [9].

#### □ □ End-to-End Path Control

In the MPLS network, LSPs need to be set up by the signaling protocols before data traffic can pass by. Additionally, LSPs setup by using the route pinning option can further enforce a sense of control over the path established. In this sense, MPLS can enforce end-to-end path control that the current IP network lacks.

#### □ □ End-to-end Resource Management

In the MPLS network, CR-LDP can allow resource preemption or reservation for the CR-LSP, this thus enables end-to-end resource management. It allows for

resource sharing among a number of CR-LSPs which compete for the same pool for resources. The weight parameter can be used to determine the CR-LSP relative priority when assigning excess nodal bandwidth or when working under congestion conditions [1].

Table 1 summarizes the QoS features enabled by the three QoS architectures.

Table 1. QoS features enabled by three architectures

QoS Features	IntServ	DiffServ	MPLS
Resource Allocation	Resource Reservation	Per-Hop Resource Prioritization	End-to-end Resource reservation or End-to-end Resource Prioritization
Admission Control	Per-hop admission control at every node	Per-hop admission control at edges	None
End-to-end Control	Reservation Path	None	Explicit Route
Traffic Engineering	None	None	Explicit Route
Security	None	DiffServ based Tunneling	MPLS based Tunneling

### 3. Research Methodology

This study uses a multi-method research methodology (Figure 2.) which was adopted from [16]. It involves three phases of study: a case study in the first phase is used to identify and specify the QoS requirements of the Internet share trading business; a QoS theoretical framework is constructed in the second phase of the study in order to build theory regarding Internet QoS technological exploration in the Internet share trading investing business context; computer simulation in the third phase is used to evaluate the proposed QoS solution built based on the proposed framework.

The role of the case study in this research is to investigate service support features of the Internet service used for the Internet share trading business. The understanding gained can help identify the QoS requirements of the business in order to establish the guidelines for the construction of the QoS theoretical framework. A single case study is chosen in this research. [10] advocate the single case study as it can help in understanding the construct being studied in as much detail as possible within its context.

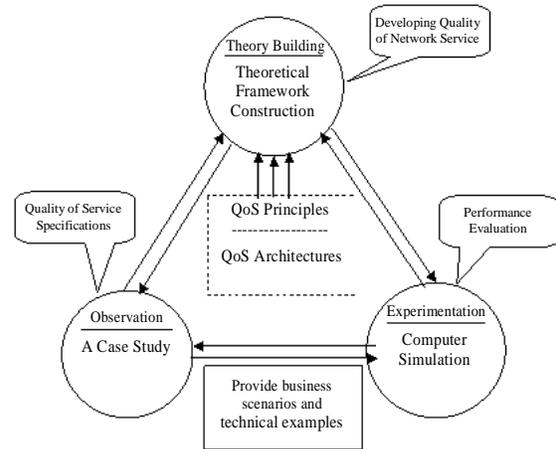


Figure 2. A Multi-method Approach

As a key part of the study, a theoretical framework construction aims to build a QoS theoretical framework, which provides both Internet QoS technology strategies and architectural design. The relevant research findings can enhance the existing Internet QoS theory. As shown in figure 2. The process of framework construction is on top of the existing IETF Internet QoS principles and QoS architectural design. This consists of two stages: building the theoretical proposition and proposing the architectural designs. The theoretical proposition is to provide Internet QoS technological strategies to meet the QoS requirements of the businesses. The architectural design is to propose a QoS architectural design to improve the service quality of the Internet for use by Internet share trading business. This architectural design is also proposed in the theoretical layer, which is a technological framework covering a set of relevant techniques. The integration of QoS strategies and QoS architectural forms a complete QoS solution.

The role of simulation in this study is to evaluate the performance of an IP network using the proposed QoS architectural design. This study uses ns<sup>®</sup> as a simulation tool. It is a tool which can provide an integrated setting to construct a simulation model, execute the simulation, and analyze the results. It can map and translate the principles of QoS architectural design into the simulation model for measurement and testing.

### 4. Case Study

#### 4.1 Case Descriptions

Established in 1975 in Singapore, the ABC group was one of the largest brokerage firms in Singapore. It offered total investment products and services in far eastern Asia including Singapore, Malaysia, Thailand, Hong Kong, Indonesia, and Sri Lanka, to satisfy investors' financial requirements.

ABC launched its electronic share trading system in 1996; it was Singapore's first electronic on-line trading

system to harness the latest technology to complement existing trading capabilities for investors. This online trading system, called ALPHA, was initially an extranet system using remote access technologies, where investors could place share orders by directly dialing into the firm's network. Having been the first mover, ALPHA succeeded in attracting most local clients who were keen to try electronic trading. In 1997, ALPHA was upgraded to support Internet based share trading so that investors could place orders through Internet channels.

ALPHA has been one of the successful cases of online business in Singapore. Through ALPHA, the firm has widened its reach and increased its brokering volume, which in turn has broadened the brand and appeal of its name. However, it has not performed well consistently. ABC received many investors' frustrated calls and many complaints regarding the business operation. The following examples illustrate some of the difficulties:

- □ Investors cannot trade shares at the price they hoped, due to the transmission delay. This is because the share price has already changed before the ALPHA system could process the order and route it to the share market.
- □ Investors cannot get real time up to the minute share prices since live quotes cannot be delivered in a timely manner.
- □ Investors wait too long for confirmation. Sometimes investors might end up buying twice as much stock as they intended.
- □ The order transaction is terminated half way through, due to system or transmission errors.
- □ Investors cannot access their accounts during busy periods.

Senior management at ABC understood that service quality enforcing only at ABC was not able to solve ALPHA problems. The Internet service is the key here, hence managers expect to find a cost-effective Internet solution to improve the quality of ALPHA. Managers brought up many issues regarding the Internet service support from the Internet service provider (ISP).

One thing is certain, quality issues always occur unpredictably. Breakdowns in service quality are mostly linked to market volatility, which is associated with sudden rise in trading volume. This specifically causes many concurrent access requests for the ALPHA system which obviously generates network congestion. This subsequently affects the business performance. Hence, the questions raised here are:

*Could ISPs monitor and control such situations?*

*Can ISPs prevent the occurrence of congestion from the outset?*

In addition, managers have always tried to compare the Internet based ALPHA with the initial extranet based ALPHA. The Internet can reach more customers and

offer a more rapid and flexible way of share trading, so it provides more business opportunities. However, it lacks the privacy and security that the extranet ALPHA possessed. The extranet allows the registered members to access the investing service thus enabling private communication to provide the business with privacy during the transmissions. There are fewer security risks on the Extranet as well. Questions raised here are:

*Can the Internet enforce such private communication?*

*Can the Internet add in more security features?*

Furthermore, the share trading business is a mission-critical business and business data generated are time-sensitive; it needs a guaranteed level of network service to ensure a satisfying level of service quality. However, such a guarantee is difficult to achieve since the Internet is a publicly shared network and ABC has to compete with other businesses for network resources. Managements' concerns here are:

*Can the Internet promise ABC better services for their online investors?*

*Can the Internet prioritize its mission critical data against other types of data?*

## 4.2 Case Analysis

The case study presents specific examples of the Internet share trading business. The above mentioned quality issues show that the current Internet cannot provide a satisfactory level of service quality for the Internet share trading business in terms of quality attributes such as timeliness, availability, reliability and security. Table 2 lists several specific examples regarding these quality issues.

Table 2. Quality Issues for Internet Share Trading

<i>Quality Attributes</i>	<i>Issues</i>
Timeliness	Slow transactions Delay in real time quotes
Availability	Service halt halfway Web site down Account Inaccessible
Reliability	Discrepancy in transactions
Security	Account being misused Account being accessed in an unauthorized way

The case study also indicates that these quality issues always occurring unpredictably. These issues are the potential risks to affect the Internet share trading businesses in attaining the consistent level of business

performance. Moreover, the current Internet seems not to have the relevant service features to improve this situation, which is summarized as follows:

□ □ Lacking monitoring and control

It seems that ISPs cannot provide effective monitoring and control for Internet services in order to prevent the occurrences of the service quality problems in a more proactive way.

□ □ Lacking service prioritization

This case suggests that ISPs can only provide one standardized Internet service for all customers. In this sense, the ISP cannot provide a customer oriented service. However, business data generated from online investing which is a kind of mission-critical data requires a higher service priority than non-mission critical data.

□ □ Lacking performance tuning

Because the volume of the share trading business is very unpredictable due to the volatile nature of the business and traffic demands on the Internet, it is very difficult for the Internet to maintain a stable and predictable level of service quality at all times. Hence, in this turbulent environment, the business requires new performance tuning tools that can quickly detect and correct the performance problems so that a consistent level of service quality required by the business is maintained. Moreover, the connection between the firm and the ISP is a common gateway where much network traffic aggregates and is easily congested by the network traffic during peak hours. The case shows that ISPs did not have such service features which can effectively minimize the possibility of congestion.

□ □ Lacking security

It is agreed that the current Internet lacks adequate security features, particularly for the sensitive financial data generated from the Internet share trading business. Hence it is necessary to enhance the security on the Internet and implement new security mechanisms.

## 5. Framework Construction

### 5.1 Design Considerations – Meet the Service Requirements

The case study above shows that the current IP network lacks certain service features and capabilities to provide a satisfactory level of service quality for the Internet based share trading. Therefore it cannot provide a preferred service for the business, it cannot consistently allocate enough network resource for the business, and it cannot dynamically adapt to the changing traffic conditions.

In this situation, it is necessary for the Internet to build new service capabilities for the Internet share trading businesses. These capabilities are also the specific requirements for building a customized QoS solution by

deploying QoS architectures. In the following sections service capabilities are discussed and QoS architectures are evaluated accordingly.

#### 5.1.1 Service Prioritization

The Internet share trading business is characterized as a mission-critical business. Mission criticality usually refers to a map of urgency and importance [9]. It requires a higher priority of Internet service support than a non-critical business.

The Internet needs techniques which can prioritize the network services to be used by different types of businesses. This is necessary because the Internet is a public-based network and business applications of the Internet share trading need to compete for the same pools of network resources with other types of applications.

Specifically, this network service prioritization can be performed in terms of critical levels of the business or specific QoS requirements. QoS requirements can be specifically described using QoS measurements such as delay, jitter, throughout and loss.

As discussed above, the IP network services are required to prioritize the network services so as to provide better quality of service for the Internet share trading business. By investigating the QoS architectures, both DiffServ and MPLS architectures can enforce resource prioritization by using resource allocation techniques. A DiffServ network can enforce per-hop based traffic prioritization, which focuses on classifying and policing the traffic, whereas the traffic prioritization enabled by an MPLS network service is on an end-to-end basis.

By investigating the requirements of Internet share trading businesses, it was decided that both prioritization ways were useful in this business context. First, since the Internet share trading business is a typical one-to-many online business, the traffic aggregation point such as the first node linking to the brokerage firm may easily be congested by the data traffic. Enforcing per-hop traffic prioritization in this focal point can mitigate the network congestion. Secondly, end-to-end traffic prioritization is also required when Internet share trading business data has to compete for the network resource with other types of data traffic over the same network path.

#### 5.1.2 Proactive Monitoring and Control

The Internet share trading business requires a proactive network solution to attain the network resource assurance rather than to passively adapt to the varying quality of the Internet. This requires new tools to monitor and control the network traffic in response to the varying situations. All three QoS architectures can enable this capability.

An IntServ network can pre-reserve a network path with the required resource for a traffic flow or a application so that the absolute service guarantee over this network path can be achieved. A DiffServ network

can enforce monitoring and control by controlling the amount of traffic of each forwarding class at the edge of the network. An MPLS network provides an explicit routing mechanism that can support constraint based routing. Constraint based routing can exercise monitoring and control by assigning pre-defined constraints such as bandwidth allocation to CR-LSPs being generated.

All the three QoS architectures can monitor and control the service in a proactive manner since they all require the QoS provisioning to specify the service profiles being committed before they enforce the service.

MPLS can enforce end-to-end path control by using explicit routes while DiffServ can enforce per-hop control. Since the Internet share trading business needs both a per-hop and end-to-end solution, both MPLS and DiffServ can be applied in this business context.

### 5.1.3 Active Performance Optimization

The Internet is required to proactively monitor and control the network services. This function specifically needs to regulate and adjust the traffic loads passing over the network channel in terms of the above service prioritization policy. This can effectively minimize the network congestions always occurring in the current Internet. Moreover, it ensures that the business application of the Internet share trading business can receive the amount of network resources required.

More specifically, the Internet needs performance optimization techniques which can effectively optimize the network performance. The specific goals include:

- □ allocate enough network resources for the business
- □ select the network path with the required network resources
- □ select an alternative network path when congestion taking place on the original path selected

The process of optimizing the performance of networks through efficient provisioning and better control of network flows is often referred to as traffic engineering. By searching proper QoS architectures, MPLS is the only QoS architecture which has this service capability. By using constraint-based routing, MPLS can perform traffic engineering to maximize the utilization of resources in the network or to minimize congestion in the network. Specifically, MPLS-based traffic engineering can “route traffic around congested hot spots and optimize resource utilization across the network” [26, p. 156].

### 5.1.4 Private and Secure Channel

The Internet share trading business requires both privacy and security in order to protect sensitive financial data from possible network layer traffic. To achieve this objective, the business requires a public shared IP network that is also capable to provide VPN services.

VPNs must be implemented using the tunneling mechanism. Both QoS architectures DiffServ and MPLS, support tunneling mechanisms to enable VPN over the Internet.

MPLS can manage a large number of tunnels than DiffServ. This is because MPLS can support more traffic differentiations due to a finer level of forwarding granularity; whereas DiffServ only supports a small number of forwarding classes based on per-hop behaviors defined. Hence MPLS is a preferred architecture to implement VPN over the public IP network so as to provide a private and secure channel for the Internet share trading business.

## 5.2 Framework

Figure 3. illustrates the proposed QoS framework which consists of two parts: QoS architectures and QoS capabilities.

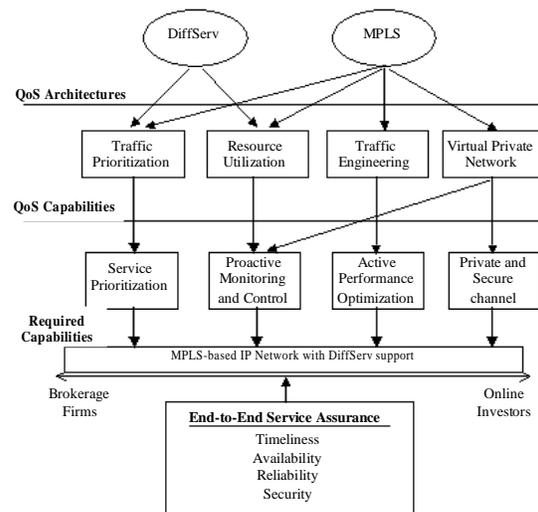


Figure 3. The Applied QoS Framework

### 5.2.1 QoS Architectural Design

MPLS is an important emerging technology for enhancing IP for both features and services. MPLS is a suitable mechanism to provide traffic engineering since MPLS allows sophisticated routing protocol capabilities as well as QoS resource management techniques to be introduced to IP networks. Hence with the advent of DiffServ and MPLS, IP traffic engineering has attracted a lot of attention in recent years.

MPLS-based Traffic engineering can provide the traffic engineering tools that are prerequisite for DiffServ. In the other hand, DiffServ can provide per-hop QoS enforced at the edge of the network so that the amount of traffic flow can be controlled. Therefore, it is likely that the combination of DiffServ/MPLS will play an

important role in the provision of some form of quantitative service guarantees in the Internet. [13]

The proposed MPLS-DiffServ architectural design is similar as the functional architecture proposed in [24]. The idea is that a MPLS-DiffServ service can support fine-grained traffic differentiation and policing in the edges of the network through the notion of IP pipes. Packet forwarding on an aggregate basis is based on the packet service class. In the core of the network, individual pipes are not distinguished and pipe level information is not maintained.

### 5.2.2 QoS Capabilities

The above MPLS-DiffServ architectural design has combined the QoS features of both MPLS and DiffServ. This can enforce the following new QoS capabilities which can provide QoS-enabled IP network services.

#### □ □ Traffic Prioritization

Both MPLS and DiffServ can build this QoS capability. MPLS enforces end-to-end based resource priorities while DiffServ enforces per-hop based resource prioritization. This proposed QoS design can enforce the traffic prioritization on both end-to-end basis and per-hop basis.

#### □ □ Resource Utilization

Both MPLS and Diffserv can enable this QoS capability. MPLS enforces this capability by end-to-end path control while DiffServ enforces this capability by per-hop control. Both architectures want to exercise control for the available network resource. Both can use traffic policing tools to regulate the traffic flow, providing both statistical bandwidth allocation by using through combining the function of traffic engineering as well as providing guaranteed bandwidth allocation [24].

#### □ □ Traffic Engineering

This QoS capability regards MPLS-based traffic engineering. With the support of the powerful MPLS function - explicit route mechanism, MPLS enforces the provision of network resources along the network paths and allows the traffic flow to use multiple path rather than single optimal path. In these ways, it optimizes the over network performance.

#### □ □ Virtual Private Network

This proposed design chose MPLS-based VPNs. CR-LDP can establish CR-LSPs across the network. Each CR-LSPs can be viewed as a tunnel. Importantly, this VPN is QoS enabled which can ensure resource assurance along each tunnel.

## 5.3 Framework Analysis

The construction of the QoS theoretical framework is done through mapping the business-required service capabilities into the QoS design. Therefore the QoS architectural design and QoS capabilities enabled by this

design can meet the quality of service requirements of the Internet share trading business. The following sections discusses how this applied QoS framework can be employed to address the quality issues in the Internet share trading business are discussed.

The quality issues regularly occurring in the share trading business are related to timeliness, reliability, availability and security of the IP network service. In the above-mentioned QoS framework, four capabilities can be enforced by the proposed MPLS-DiffServ architectural design that can solve these quality issues. The details are discussed below.

Traffic prioritization can prioritize the network services to be used by the Internet share trading so as to ensure the sufficient resource allocation required by the business. In addition, it also allows the Internet share trading business to preempt the network path with the required network resource.

Resource utilization can provide the specific tools to proactively monitor and control traffic flows to ensure the business will get the committed network resource over the paths between brokerage firms and online investors.

Traffic engineering enabled by MPLS based explicit route mechanisms can dynamically optimize the performance of the overall network. This ensures effective link utilization so that the business can select the network path with the sufficient network resource or can select the alternative network path when network congestion is taking place on the original path selected.

VPNs can be used to construct the private channels over the public network. These private channels only allow the authorized members of the brokerage firms to be accessed.

All these QoS capabilities can improve speed, reliability and availability of online investing services. In addition, VPNs can enhance the security and can effectively prevent denial-of-service security attacks.

## 6. Performance Evaluation

Based on the above-proposed framework, the proposed IP network solution should deliver service with lower delay, lower jitter, higher throughput and lower loss compared to current IP networks. However, this is the assumption subject to performance tests. Hence a performance study was carried out by using the computer simulation tool *ns* version 2.1b8a (<http://www.isi.edu/nsnam/ns>). In order to make the study worthwhile, two simulations were conducted, including both the proposed IP network service and the current IP network service. Performance of the proposed IP network was evaluated through the comparisons of two sets of simulation results by using the measures mentioned above: delay, jitter, throughput and loss

Figure 4. shows the general simulation model built by using *ns* simulator version 2.1b8a (*ns2*). It contains the

details regarding IP network behaviors includes topology, traffic model and protocol design

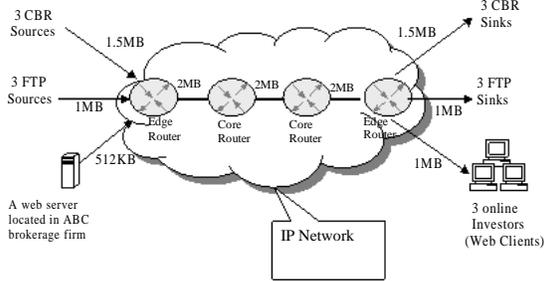


Figure 4. General Simulation Model

In order to make a fair comparison for the performance of two types of Internet services, the two simulation models apply the same topology and traffic sources. The key differences between the two simulations are the service functions and associated functional architecture implemented in the routers.

The simulation results presented in Figure 5. shows that the proposed IP network with QoS support can consistently provide better performance than the current IP network.

## 7. Conclusions

The paper has established an applied QoS theoretical framework for the Internet share trading business. This framework provides some practical guidelines for fast and secure Internet services with high reliability and high availability so that the quality issues raised in the Internet share trading business can be addressed.

One contribution of this paper is the identification of the service capabilities required by the Internet share trading business. Taking into account these business-required capabilities, the applied QoS theoretical framework constructed can provide the relevant QoS capabilities that match with the identified service capabilities required by the Internet share trading business. This has opened up a broad research perspective for developing a customizable QoS solution for electronic commerce, not just limited to the Internet share trading business.

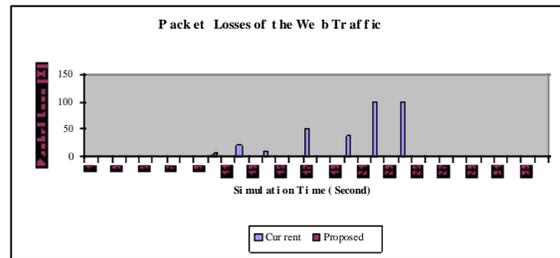
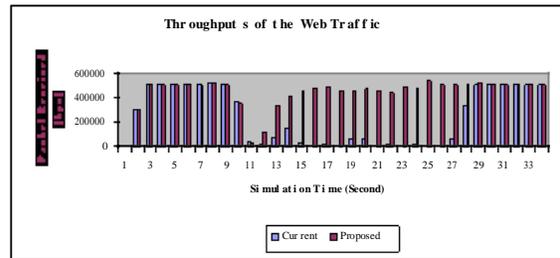
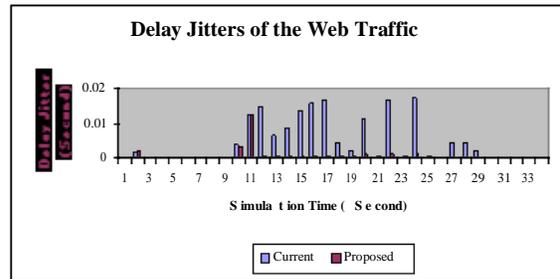
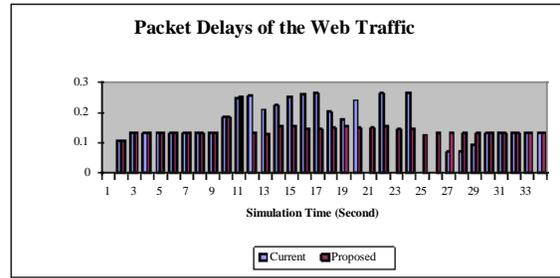


Figure 5. Simulation Results

## References:

- [1] Aboul-Magd, O. & Jamoussi, B. "QoS and Service Internetworking Using Constraint-Route Label Distribution Protocol (CR-LDP)". *IEEE Communications Magazine*, May 2001, 134-139.
- [2] Armitage, G. "MPLS: The Magic Behind the Myths". *IEEE Communications Magazine*, January 2000, 124-131.
- [3] Bhimani, A. "Securing the Commercial Internet". *Communications of the ACM*, June 1996, 39-46.
- [4] Blake, S., Black, D., Carlson, M., Davies, E., Wang, Z. & Weiss, W. *An Architecture for Differentiated Services: IETF RFC 2475*, 1998.
- [5] Braun, T., Guenter, M. & Khalil, L. "Management of Quality of Service Enabled VPNs". *IEEE Communications Magazine*, May 2001, 90-98.
- [6] Buckman, R. "On-Line Brokers Handle Volume". *Wall Street Journal, New York*, Aug 6, 1998.
- [7] Cox, J. & Dale, B. G. "Service Quality and E-commerce: an Exploratory Analysis". *Managing Service Quality*, 2001, 11(2), 121-131.
- [8] Croll, A. & Packman, E. *Managing Bandwidth: Deploying QoS in Enterprise Networks*. Upper Saddle River, NJ: Prentice Hall, 2000.
- [9] Dyer, W. G. & Wilkins, A. "Better Stories, Not Better Constructs, to Generate Better Theory: A Rejoinder to Eisenhardt". *The Academy of Management Review*, 1991, 16(3), 613-619.
- [10] Hoffman, T. "E-brokers Alert: Invest in Systems Capacity". *Computerworld*, 1999, 33(9), 14.
- [11] Konana, P., Menon, N. M. & Balasubramanian, S. "The Implications of Online Investing". *Communications of the ACM*, 2000, 43(1), 35-41.
- [12] Leskela, L. & Tang, D. *Accelerating Internet Securities Trading Adoption in Asia/Pacific*: Gartner Group Inc. 2000.
- [13] Mathy, L., Edwards, C. & Hutchison, D. "The Internet: A Global Telecommunications Solution?" *IEEE Network*, July/August 2000, 46-57.
- [14] NASD. *NASD Regulation Issues Guidance Regarding Stock Volatility*: NASD Notice to Members 99-11, 1999.
- [15] Nelson, M. G. & Bachelder, B. "Attacks on E-businesses Trigger Security Concerns." *Informationweek*, 2000(773), 28-30.
- [16] Nunamaker Jr., J. F., Chen, M. & Purdin, T. D. M. "Systems Development in Information Systems Research." *Journal of Management Information Systems*, 1991, 7(3), 89-106.
- [17] Parasuraman, A., Zeithaml, V. A. & Berry, L. L. "Understanding Customer Expectations of Service". *Sloan Management Review*, Spring 1991, 39-48.
- [18] Saltzer, J. H., Reed, D. P. & Clark, D. D. "End-to-End Arguments in System Design". *ACM Transactions in Computer Systems*, 1984, 2(4), 277-288.
- [19] SEC. *Tips For Online Investing: What You Need to Know About Trading in Fast-moving Market*: U.S. Securities & Exchange Commission(SEC) Online Publications, 1999.
- [20] SEC. *Trade Execution: What Every Investors Should Know*: U.S. Securities & Exchange Commission(SEC) Online Publications, 1999.
- [21] Selwyn, J. "Brokers cope with outages". *Computerworld*, 1999, 33(7), 1999.
- [22] Shand, D. "Banish Bottlenecks". *Computerworld*, 2000, 34(15), 84-86.
- [23] Teeter, C. & Schointuch, B. "Controlling Internet Service Quality". *Credit Union Executive Journal*, Nov/Dec 2000.
- [24] Trimintzios, P., Andrikopoulos, I., Pavlou, G., Flegkas, P., Griffin, D., Georgatsos, P., Goderis, D., Tjoens, Y., Georgiadis, L., Jacquenet, C. & Egan, R. "A Management and Control Architecture for Providing IP Differentiated Services in MPLS-based Networks". *IEEE Communications Magazine*, 2001, 39(5), 80 -88.
- [25] Unsal, F. & Movassaghi, H. "Impact of Internet on Financial Service Industry: A Case Study of On-line Investing". *Managerial Finance*, 2000, 27(7), 54-65.
- [26] Wang, Z. *Internet QoS: Architectures and Mechanisms for Quality of Service*. San Francisco: Morgan Kaufmann, 2001.

# Beyond Customer Relationship Management: Selling Chain Management for E-Business Practices

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## Abstract

Traditional 4Ps (product, price, place, and promotion) sales/marketing strategies are no longer a match for the dynamism of global markets in the e-business era. Today's one-to-one relationship marketing practice requires significantly more information about customers' behaviors, preferences, and patterns than other marketing strategies. Most sales opportunities in enterprises arise in a complex web of team-selling environments where sales team members need to share information, coordinate activities, and align sales processes in order to achieve a sales goal. Enterprises that used to implement CRM applications realize that their systems, which are not sufficiently flexible and interactive to streamline sale processes, have failed to engage customers in ways that create values, enhance individual purchasing experiences and retain loyalties. All these issues drew attentions from CRM to selling chain management. Selling chain management is a combination of customer relationship management, integrated marketing communications, and order fulfillment strategy situated in a multi-channel environment. The major purpose of selling chain management is to transform customer contact into profits. This paper shows that the integration of sales, marketing, and customer service applications with business intelligence system will help enterprises to manage one-to-one marketing and relationship management strategies. The selling chain management that reinvented itself from traditional sales/marketing strategies will undoubtedly be the best solution to today's e-business Internet marketing.

## 1. The Missing Link of B2B2C

The globalization of markets and the resulting competitions are the driving forces for organizations to optimize their business strategies and operations constantly. Today, customers are in charge and make the rules. Consumers are demanding solutions customized to meet their specific needs. Consequently, the challenge is shifting from product-centric marketing to customer-centric marketing. In order to compete in today's real-time economy, every business must be able to quickly identify and respond to the changing market conditions and customer needs. These sales challenges are made worse further by difficulties in pricing, promotion, and relationship-management. In the real-time economy, sales have a deep impact on downstream decisions, as well as decisions related to outside supply chain trading partners. For these reasons, Customer Relationship Management (CRM) now moves from a pure sales

productivity tool to a technology-enabled relationship management strategy in a supply chain scheme.

The CRM is a combination of business process and technology seeking to profile an enterprise's customers from different perspectives. It contains call center service and support, customer contact management, and sales/marketing automation that help to eliminate cost inefficiencies by streamlining and unifying customer information and other internal/external administrative works. However, due to the current one-to-one relationship marketing practices, enterprises that used to implement CRM applications realize that their systems, which are not flexible and interactive to streamline sale processes, have failed to engage customers in ways that create values, enhance individual purchasing experiences, and retain loyalties. Many enterprises with extended selling channels have difficulties responding to the dynamic market conditions. Therefore, a new generation of application framework for one-to-one relationship selling is emerging. Selling chain management is a combination of customer relationship management, business intelligence, enterprise application integration (EAI), and integrated sales/marketing strategy situated in a multi-channel environment.

## 2. The New Dimension of Channel Integration

Emphasis has been placed on the back-office integrations since the emerging of new supply chain practices in the mid-1990s. Today, there are many strategies on the enterprise back-office system integrations, such as enterprise resource planning (ERP) and enterprise application integration (EAI). These solutions are trying to create a unified communication channel that allows enterprise business processes to permeate different departments, divisions, and supply chain partners. In the meantime, there is a growing trend in the marriage of ERP with CRM. The reasons are in two folds; (a) to maintain the integrity of business processes from production to sales automation and (b) the growing importance of customer care. With the combination of ERP and CRM, the enterprise will be more adaptive and flexible to engage customized services.

In today's e-commerce, the customers are in control, and a business must realign its value chain around the customers to eliminate inefficiencies and customize information, products, and services. A set of CRM is not enough to handle diverse group of customers, especially when dealing with one-to-one relationship marketing. To maximize selling power and retain customers, selling

chain management is becoming the central issue in gluing enterprise back-office business-to-business (B2B) and store-front (or front-end) business-to-customer (B2C) practices (Figure 1).

The applications of selling chain management, by definition, must automate processes across multiple user types and functional areas. Selling chain management is a broad set of sales/marketing solution that includes the following strategic areas: data acquisition and analysis (such as data mining and warehousing), marketing intelligence (such as business intelligence tools), sales force automation (SFA), customer services (such as CRM), product catalog and pricing services, proposal/quote/contract management, order management, fulfillment, and the integration of back-office system (such as ERP). The purpose of selling chain management is to build an adaptive marketing strategy such that the entire selling process will be more active and flexible than traditional 4Ps marketing approaches allowing sales teams to better handle any sales activities.

This new dimension of channel integration strategy increases customers' value by satisfying customers' requirements and providing them with the best solution. With marketing intelligence, personalized customer care service will offer valued-added one-to-one relationship marketing to enhance individual purchasing experience and retain customer loyalties with enterprise. This effort can be achieved through the introduction of business intelligence in selling chain practices as will be discussed in the following section.

### 3. Technological Framework

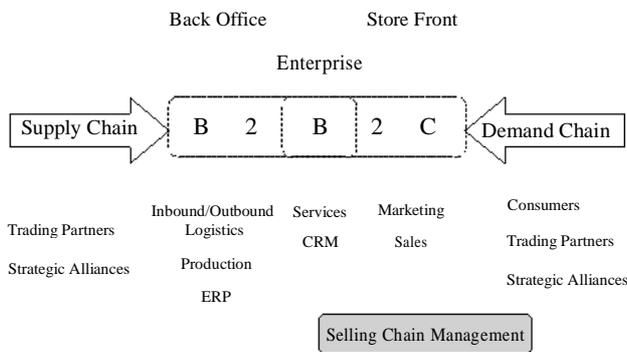


Figure 1 Enterprise B2B2C Model

Selling chain, with an emphasis on purchasing process and customer care, represents a new shift in enterprise computing. This new dimension of channel integration brings both opportunities and challenges to enterprise to refine their business strategies and supporting information systems. The application of selling chain management includes technologies from initial customer contact to production and delivery of final goods or services. The scope also focuses on the gathering of customer data and information. Data acquisition is an important issue in

selling chain management. In today's e-commerce practices, all business data are transmitted over a variety of communication channels because the essence of e-commerce lies in the communications of business data among organizations, supply chain trading partners, and customers. For a typical buying pattern, click-stream through an enterprise's web site, buttons pushed on a touch-tone phone, postal mail/email and faxes are all part of communication with customers. This information by now is not captured in meaningful way to maintain a comprehensive view of the attributes and patterns of customers. With the focus shifts from product-marketing to customer-centric marketing, business intelligence (BI) helps to coordinate information between brick-and-mortar and online initiatives. It relies on integrated data from a variety of information sources: web site, call centers, customer profile and transaction log, operational database, ERP system, and even third party data. The BI analytical and segmentation applications offer tools for data mining as well as decision-making in enterprises. In selling chain management, data acquisition does not only capture customer preferences and patterns, but it also presents customers with personalized information in the purchasing process. The fully integrated selling chain management application has the ability to record and analyze all the activities of prospects and customers, whether the contact mechanism is via the web or a call center. This "automatically-collected" treasure of user behavior information theoretically gives the enterprise a huge advantage over brick-and-mortar competitors, who cannot easily record customer and prospect behavior. The existence of an effective relationship management and click-stream/call-stream data warehouse is one of the most important long-term success differentiators in the e-commerce practices. Other technologies, such as interactive voice response (IVR), computer telephony integration (CTI), are beneficial to selling chain management. The fully interactive nature of the Internet changes everything in the world of self-service. The blending of SFA with customer self-service brings new business opportunities. Relevant information and intelligence support processes all can be aligned and implemented in real-time at anywhere.

With the convergence of B2B, B2C, BI, and real-time relationship management, the personalization of customer information is now possible. A robust selling chain management suite for customer care applications enables new kinds of interactions, new kinds of information, and comprehensive access to all customers and enterprise portals. This customer care can foster joint problem-solving, convenient self-service, and self-selling. Given the information customers need in the purchasing process, they will sell to themselves and service their own information needs. In other words, customers can be an enterprise's best sales forces. The technologies to facilitate these highly interactive communications are summarized in Figure 2.

#### 4. Conclusion

Customization is the rule of the 21 century marketing trend. Multi-channel and multi-technology strategies represent the next frontier of sales force integration. Personalization provides value to customers by allowing them to find solutions that better fit their needs and saves them time in searching for their solutions. By interacting with customers electronically, their buying patterns can be evaluated and the services can be provided. To deliver the right product or service to the right customer for the right price via the right channel at the right time are the essence of selling chain management.

This paper shows that the integration of sales, marketing, and customer service applications with business intelligence system will help enterprises to manage one-to-one marketing and relationship

management more effectively. This technological framework still hold promising with the coming era of mobile business. The IP convergence strategy will provide a solution that joins the two worlds of voice communications (telephony) and data traffic together. The usefulness of the mobile channel will be largely driven by new selling chain applications that enhance the overall customer values. With self-service applications in hand, customers will be able to touch the resource of an enterprise. The customer drives the entire value chain, determining what is to be produced, when, and at what price. The customer will interact with the entire business ecosystem, not just the individual company. The selling chain management that reinvented itself from traditional sales/marketing strategies will undoubtedly be the best solution to today's e-business Internet marketing.

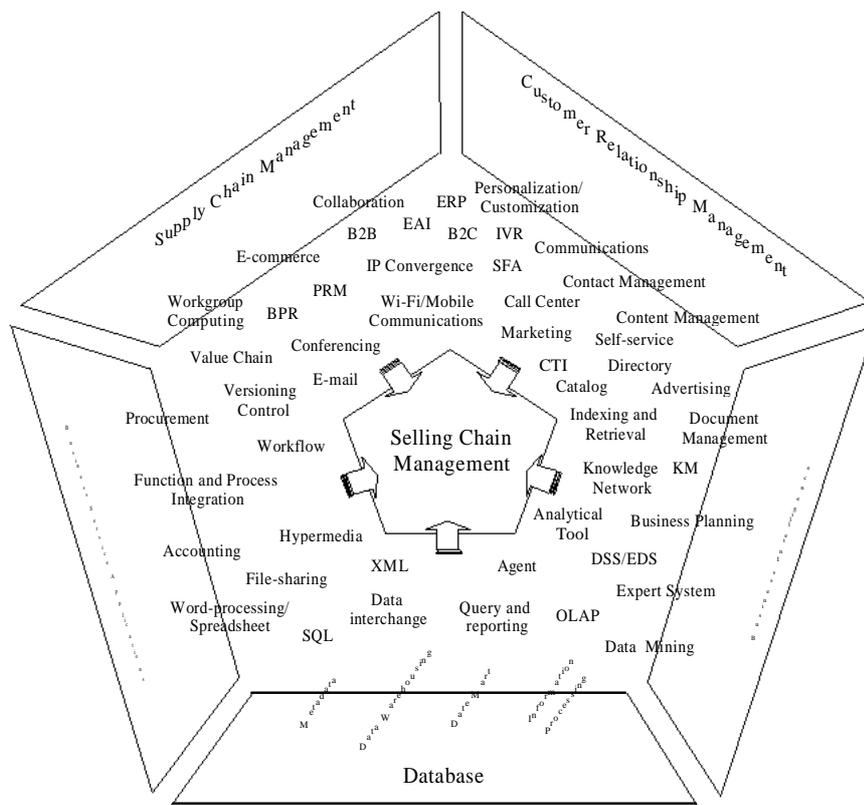


Figure 2 Selling Chain Management Technological Framework

# Towards Customer Knowledge Management: Integrating Customer Relationship Management and Knowledge Management Concepts

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## Abstract

The concepts of customer relationship management (CRM) and knowledge management (KM) have been recently gaining wide attention in business and academia. Both approaches focus on allocating resources to supportive business activities in order to gain competitive advantages.

CRM focus on managing the relationship between a company and its current and prospective customer base as a key to success. A good relationship with the customer leads to higher customer satisfaction. Content customers are loyal and therefore more valuable customers. This directly affects the revenue stream.

KM sees the knowledge available to a company as a major success factor. Through superior knowledge companies can accomplish their results faster, cheaper and with higher quality than their competition. Knowledge about customers, markets and other relevant factors of influence allows faster utilization of opportunities and more flexible reaction to threats.

From the perspective of a process owner both CRM and KM approaches promise positive impact on the cost structure and revenue streams for a company in return for allocating resources from the core business into supportive functions. This investment is not without risk as many failed projects in the areas of CRM and KM demonstrate.

In this paper we show that the benefit of using CRM and KM can be enhanced and the risk of failure reduced by integrating both approaches into a customer knowledge management (CKM) model. Managing relationships requires managing knowledge for the customer, knowledge about the customer and knowledge from the customer. KM takes the role of a service provider for CRM, managing the four knowledge aspects content, competence, collaboration and composition to satisfy customer requests within stated budget restrictions. The findings are based on literature analysis and six years of action research, supplemented by case studies and surveys.

## 1. Introduction

The concepts of customer relationship management (CRM) and knowledge management (KM) have been recently gaining wide attention in business and academia. Both approaches focus on allocating resources to supportive business activities in order to gain competitive advantages. Although both concepts are currently mostly

treated as separate research areas, we see high synergy potential in an integrated approach.

### 1.1 Objectives

The challenge of achieving a good relationship can be seen as serving each customer in his preferred way, therefore requiring to manage “customer knowledge” [4]. Many knowledge management approaches, as presented by KM models, see managing knowledge as independent from the supported business processes. Knowledge and its management is seen as inherently valuable, a view not generally shared by the process owners, who bear the costs for supportive activities but are measured by their ability to generate revenue and control costs, which in many cases is not measured in knowledge, but in services or products [7, p. 1].

In this paper we will show that integration of CRM and KM concepts on process level are beneficial for both management approaches. A CRM-oriented knowledge management focuses on the knowledge most valuable to the company: Customer knowledge. A KM-oriented customer relationship management receives a framework to manage the knowledge required for high quality relationships in a cost effective way. Both approaches directly interface in the area of information management, as both decide which content should be explicated and disseminated. The resulting customer knowledge management (CKM) model describes basic elements for a successful customer knowledge management. It wants to serve as a frame of reference for integrated CKM activities both on enterprise and project level.

In order to integrate KM and CRM on process level, both resource oriented concepts must be aligned towards the business oriented process view. This modification is based on a literature analysis and is the reason for the emphasis on the theoretical foundations. Furthermore, the implications of the integration approach described in chapter 3.3 as well as the case study in chapter 4 provide tangible recommendations for practitioners.

### 1.2 Research scope, methodology and structure

The CKM model bases on the foundations of business engineering (BE), a research approach developed at the institute of information management (IWI-HSG) at the University of St. Gallen [28, p. 13]. Business engineering differentiates between the levels of strategy, processes and

systems. The research described in this paper concentrates on the process level of CRM, KM and subsequently CKM, while on different points interdependences with the system level are discussed.

The primary research approach employs “action research” as defined by GUMMESSON: “On the basis of their paradigms and preunderstanding and given access to empirical, real-world data through their role as change agent, [...] action scientists [...] generate a specific (local) theory which is then tested and modified through action. The interaction between the role of academic researcher and the role of management consultant, within a single project as well as between projects, can also help the scientist to generate a more general theory, which in turn becomes an instrument for increased theoretical sensitivity [...]” [17, p. 208]. This foundation is enriched by complementing in-depth case study that help validating research questions, aligning existing models with reality, and finally prompting new research challenges. The CKM model is based on nearly 6 years of research<sup>1</sup>. The research partners AGI, Asean Brown Boveri, Bank Austria, BASF, Credit Suisse, Deutsche Telekom, DKV, Helsana Insurance, Landesbank Baden-Württemberg, St. Galler Kantonalbank, Swisscom IT Services, Union Investment and Winterthur Life & Pension.

This paper is structured into three main chapters. The theoretical foundation in chapter 2 analyzes some current approaches in the fields of CRM and KM and identifies relevant elements concerning integration into a CKM model. The necessary modification to the current approaches and the main elements of the integrated model are discussed in chapter 3. Chapter 4 offers a sample application of the model in a business environment, based on an action research report conducted with a research partner. The paper concludes with a summary, a critical reflection and an outlook on further research possibilities.

## 2. Theoretical Background

### 2.1 Customer Relationship Management

Increasing competition and decreasing customer loyalty have led to the emergence of concepts that focus on the nurturing of relationships to customers. Customer Relationship Management (CRM) emerged as an amalgamation of different management and information systems approaches, in particular Relationship Marketing and technology-oriented approaches such as Computer Aided Selling (CAS) and Sales Force Automation (SFA). Following SHAW, we define CRM as an interactive process achieving the optimum balance between corporate investments and the satisfaction of customer needs to generate the maximum profit. It involves: [40]

- measuring both inputs across all functions including marketing, sales and service costs and outputs in terms of customer revenue, profit and value.
- acquiring and continuously updating knowledge about

customer needs, motivations and behavior over the lifetime of the relationship.

- applying customer knowledge to continuously improve performance through a process of learning from successes and failures.
- integrating the activities of marketing, sales and service to achieve a common goal.
- the implementation of appropriate systems to support customer knowledge acquisition, sharing and the measurement of CRM effectiveness.
- constantly flexing the balance between marketing, sales and service inputs against changing customer needs to maximize profit.

#### 2.1.1 Knowledge in CRM processes

To integrate marketing, sales, and service activities, CRM requires strong integration of business processes which involve customers. These front-office or CRM processes are mostly unstructured and non-transactional. Their performance is predominantly influenced by the underlying supply with knowledge about products, markets, and customers [6][13][36].

CRM processes can therefore be considered as knowledge-oriented processes with the following characteristics which have a strong correlation: [12]

- Knowledge intensity*: CRM processes require knowledge from heterogeneous, not necessarily computational sources, to pursue process goals.
- Process complexity*: CRM processes mostly have complex structures or even no clear structure at all. This implies that a high degree of knowledge is necessary for the execution of a process.

Knowledge flows in CRM processes can be classified into three categories:

- Knowledge for customers* is required in CRM processes to satisfy knowledge needs of customers. Examples include knowledge about products, markets and suppliers [13].
- Knowledge about customers* is accumulated to understand motivations of customers and to address them in a personalized way. This includes customer histories, connections, requirements, expectations, and purchasing activity [4][6].
- Knowledge from customers* is knowledge of customers about products, suppliers and markets. Within interactions with customers this knowledge can be gathered to feed continuous improvement, e.g. service improvements or new product developments [13].

Managing these different knowledge flows is one of the biggest challenges of CRM. The most important issue is how to collect, store, and distribute only the knowledge that is needed and not waste time and effort on collecting and storing useless knowledge [4].

To identify relevant knowledge that is needed in business processes, methods of Business Process Engineering can be used [3][18][19]. To integrate different CRM processes, often process reengineering projects are

<sup>1</sup> Further information under: <http://ccckm.iwi.unisg.ch>

carried out. These projects provide process models that can form the basis for an analysis of knowledge flows in CRM processes.

To determine CRM processes that need to be integrated and analyzed with regard to their knowledge needs, we will analyze existing conceptualizations of CRM.

### 2.1.2 Current CRM approaches and process orientation

The origins of CRM can be traced back to the management concept of *Relationship Marketing* (RM). LEVITT was one of the first to propose a systematic approach for the development of buyer-seller relationships [22]. Relationship Marketing is an integrated effort to identify, maintain, and build up a network with individual customers and to continuously strengthen the network for the mutual benefit of both sides, through interactive, individualized and value-added contacts over a long period of time [39, p. 34].

RM is of largely strategically character. As such, although business processes are regarded as important [30], a holistic view on business processes connected to RM is missing.

On the other hand, CRM was influenced by several information systems concepts, focusing on distinct application areas. For example systems for Computer Aided Selling (CAS) and Sales Force Automation (SFA) were responsible for the control and automation of sales processes, whereas other systems for service or marketing automation focused on service resp. marketing processes. In the course of process integration these systems continually merge towards integrated CRM systems.

A widely accepted classification of systems connected to CRM is the following [37, p. 8]:

- *Operational* CRM systems improve the efficiency of CRM business processes and comprise solutions for sales force automation, marketing automation, and call center/ customer interaction center management.
- *Analytical* CRM systems manage and evaluate knowledge about customers for a better understanding of each customer and his or her behavior. Data warehousing and data mining solutions are typical systems in this area.
- *Collaborative* CRM systems manage and synchronize customer interaction points and communication channels (e.g. telephone, email, web).

Whereas operational CRM systems focus on the support of distinct front-office business processes, analytical and collaborative CRM systems only have a supporting role for operational CRM.

Apart from the strategy-oriented concept of RM and systems-oriented concepts, there are several CRM approaches with special focus on business processes [36]. Most of these approaches define marketing sales, and service as core CRM processes, neglecting that these are functional areas which have to be integrated by defining cross-functional business processes. Others focus on specific activities, but don't propose a process framework for

CRM.

Our goal is to overcome these shortcomings by proposing a process model consisting of business processes relevant in the context of CRM. This framework may be used as a starting point for the analysis of knowledge flows in CRM processes.

### 2.1.3 Status and challenges of CRM in real-world applications

Case studies and action research with our business partners support the assumption that the management of knowledge in CRM processes is a critical success factor.

Especially important for our business partners is the identification of prospective customers as well as the discovery of cross- and up-selling opportunities within the existing customer base. We thus observe an extensive use of applications for analytical CRM. Although several companies are far advanced in the implementation of a continuous process for analytical CRM, the majority still has difficulties in managing the relevant knowledge. In particular, the challenge to ensure a consistent knowledge flow from the point of development of knowledge about the customer (in marketing, sales, and service) to the point of utilization, where the knowledge has to be presented in adequate form and complexity is far from being solved.

Another subject of considerable relevance is the management of customer service. All of the participating companies have call-centers that handle service inquiries. One of the major challenges remains the provision of the right knowledge for call-center staff to handle inquiries in an adequate timeframe. To address this challenge, some companies have projects for the implementation of supporting knowledge management tools. Another future challenge is the use of multiple communication channels to address customer service needs. All companies show further potential to exploit self-service technologies with the aim of increasing service quality and decreasing service costs. Using these technologies will raise the question of how to synchronize different communication channels to ensure consistency towards the customer.

Closely connected to service management is the handling of customer complaints. Although all our partner companies have a process for complaint management, many reveal shortcomings in the analysis and utilization of complaints for continuous improvement.

### 2.1.4 Summary

Literature research and work with our business partners suggest that the management of knowledge in CRM processes is a critical success factor. For an analysis and improvement of knowledge flows, a CRM process model can be used as starting point. Existing conceptualizations of CRM in the literature either lack process-orientation or don't provide a process framework for CRM that is detailed enough to suit this purpose.

## 2.2 A review on Knowledge Management Models

The steady interest for knowledge management in academia and business circles alike has spawned many KM models, that try to capture the inherent qualities as well as the dissemination and development characteristics of knowledge in order to assess methods and techniques of managing it in a business environment.

While many knowledge management models offer valuable insights into the nature of knowledge, their difficulties of justifying the management of knowledge within the business environment is a point of constant criticism [5], [8]. To understand the reason for this it is important to analyze the foundations of the modeling approaches used. Almost all knowledge management models can be traced back to a basic approach when analyzing knowledge. The models either view knowledge as an entity with distinctive attributes, that can be decomposed and its details analyzed, or they view it as an integrated whole and focus on its relations to the surroundings. Within this paper the former view will be called an epistemological perspective, the latter an ontological perspective. The following analysis provides an introduction into this differentiation.

### 2.2.1 Epistemology oriented KM models

As a philosophical research area, epistemology investigates the nature of knowledge itself. Epistemological knowledge management models therefore view knowledge as an entity that can be decomposed into discrete, relevant attributes, based on the epistemological foundation held by the modeler. There are many different epistemological views in philosophy, but mainly the cognitivist and the autopoietic approaches have been of significance in the area of knowledge management [44]. The cognitivist approach describes knowledge as stored in distinct knowledge structures, that are created through rule based manipulation and can exist independently from an individual, while the autopoietic approach states that knowledge is context sensitive and basically embodied in the individual [44, p. 55f.]. The following description will focus on the autopoietic approach on knowledge management.

According to the autopoietic epistemology an individual observes its environment and acquires knowledge by interpreting data through an informational process [42]. Individuals can actively transfer knowledge between themselves through articulation and different types of interaction [45].

Based on the autopoietic theory, the main differentiating characteristic of knowledge is the difficulty of its articulation. Knowledge that can be easily articulated is labeled “explicit knowledge”. Knowledge, that is difficult to articulate and therefore difficult to transfer is labeled “tacit knowledge” [32, pp. 3-25] which was superseded by the term “implicit knowledge”. With their SECI knowledge management model Nonaka and Takeuchi have formulated an encompassing epistemological autopoietic oriented knowledge management model [27, p. 45]. Other examples of epistemological oriented knowledge manage-

ment models with an autopoietic approach include the models of Boisot [1] and McLoughlin & Thorpe [25].

### 2.2.2 Ontology oriented KM models

Also based on philosophical research, an ontology represents systematic account of Existence. It is an “explicit specification of a conceptualization: the objects, concepts, and other entities that are presumed to exist in some area of interest and the relationships that hold them” [16, p. 1].

Ontology knowledge management models therefore view knowledge as “black box”. The characteristics of knowledge are defined through its relationships with a constructed universe of discourse, encompassing all dimensions that are relevant to the modeler.

Modeling dimensions frequently used by ontological knowledge management models include a process dimension, an agent dimension (individual vs. group) and a financial dimension. The latter is based on the intellectual capital research, and will, due to the specific aims of the models, not be discussed further within this paper.

Process oriented KM models focus on the characteristics of knowledge during its life cycle. They analyze the relationships and environmental variables that influence the processes of knowledge development, dissemination, modification and use. Examples for process oriented KM models include Probst [34] and Wiig [47]. Agent oriented KM models focus on the characteristics of knowledge during the flow between individuals. They analyze the variables that expedite or hinder the flow of knowledge in social networks. Examples for agent oriented KM models include Wenger [46] and Enkel [11].

### 2.2.3 Hybridization of KM models

The perspectives of epistemology and ontology have high synergy potentials. Though it is possible to analyze the structure of an entity and its relations separately; in trying to assess the business benefits of knowledge management, both the inherent characteristics and relevant relationship variables of knowledge must be taken into account.

Most KM models developed within the last decade therefore exhibit characteristics of both views. Nonaka has integrated an agent ontology dimension in 1994 [20] and he tries to fully bond both views in his concept of “ba” [27]. The process oriented KM model of Demarest focuses by definition on the processing of explicated knowledge [7]. Still a fully balanced model is yet to be created [24].

### 2.2.4 The inherent value of knowledge

Peter Drucker and others speak of knowledge as “the most important resource of the 21<sup>st</sup> century” [9, p. 1]. To determine what kind and how much knowledge a business process requires to achieve top performance must be the first step of a supportive knowledge management system [7, p. 1].

Epistemology oriented KM models share an inherent

disability to assess this question. They focus on the inner characteristics of the entity knowledge and neglect the relationships to the environment per definition. To assess whether a certain knowledge entity is explicit or implicit does not allow to draw any conclusions about its value in a business process. Epistemological KM models are therefore not able to support business processes when trying to identify and manage valuable knowledge.

Ontology oriented KM models display relationships between knowledge entities and their environment. They should therefore be able to help the process owners to identify and manage valuable knowledge by offering a suitable knowledge management process dimension. However when analyzing ontological KM models, it becomes apparent that many processes described are completely self oriented. They focus on the knowledge life-cycle, such as knowledge development, knowledge dissemination and knowledge modification [23]. Based on this view, knowledge management processes are independent business processes, taking a similar position in an enterprise as marketing or sales; knowledge itself and its management possesses inherent value.

We criticize this endorsement of inherent value to knowledge and knowledge management. While knowledge becomes more important to all business processes, it is still a resource that abides the laws of economics: It has a diminishing marginal utility and its management does normally not directly generate business value. A change in alignment of the KM models is required to tap the supportive performance for managing knowledge in a CRM environment.

### 2.2.5 Action research results

The stated gap between the self-conception of knowledge management models and the requirements of business process owners could be verified through research within our partner companies.

A survey based on 241 questionnaires with a reply of 60 and 19 detailed telephone interviews comprised the following results: The managers demand an evaluation framework that supports them in operating the content flow within and between their processes and maintaining a concise and performance oriented content base. Information requirements driven by new CRM systems strain the service capabilities of employees with customer interaction in subsidiaries and call centers. A manager's issue is not about how to commonly create and disseminate knowledge in an effective way. While the research partners spent substantial resources on knowledge management they still try to get their exponentially growing content base of semi-structured documents under control. They want to know which content to keep in which state to run their processes more efficiently and effectively.

Therefore another area of intense interest is the identification of employees according to their competences. While process managers see distinct improvement potential using expertise directories or yellow pages, the restrictive European data protection acts and the ambiguous

position of these systems concerning human resources activities, stalls such approaches in many companies. While several research partners have isolated solutions in single departments, especially IT and internal consulting, only one partner in the insurance industry has set up a company wide skills management project. To analyze the customer requirements in this project a two day interview session was conducted. 9 stakeholders with customer oriented assignments ranging from operatives to the middle management were interviewed in 45 to 60 minutes sessions. All interviewees confirmed a high demand for expertise location services within their business processes and were willing to support the project financially. The stated requirements included a better transparency of their own workforce concerning skills, qualifications, abilities and required trainings as well as the potential of fast identification of required resources within other parts of the company. The main difficulties were seen in constructing a competences base relevant to the own business process while minimizing the effort for the employees updating their personal profiles.

Storage of knowledge across business processes is another area of interest for research partners. While a third of the companies have large scale community structures in place, most of them concentrate in one core process, such as research & development and other areas of high expertise. In organizations that structure along customer oriented processes communities of practice that span organizational team structures are currently not explicitly managed. The lack of possibilities to bridge the temporal and geographical gaps between the different customer teams is seen as a major hindering factor. Nevertheless, the role and management of these complementary organizational structure is seen as vital. One research partner has started a multi-million euro project with a major focus on enhancing his capabilities of using forms of virtual work independent from temporal, geographical constraints and embedded into the existing organizational structure.

### 2.2.6 Summary

While the integration of epistemological and ontological approaches into an encompassing knowledge management model is progressing, the direct process support by knowledge management required by the research partners and survey participants can still not be served. This limitation is based on the self-conception of KM models stated in chapter 2.2.4. To address this challenge, we propose a customer oriented knowledge management (cKM) model described in chapter 3.2.

## 3. Proposing a CKM framework

### 3.1 CRM process model

Based on previous research by SCHMID, literature research and work with our business partners, we propose the following process model for CRM which describes business processes relevant for CRM [35]. Based on this model, we can identify relevant activity fields for knowl-

edge management, in order to improve these processes.

### 3.1.1 CRM business processes

Marketing, sales, and service are primary business functions [33] with the characteristics of a high degree of direct customer interaction and knowledge intensity, which makes them primary targets for CRM. We therefore derive our process model by detailing these functions into relevant business processes which may be cross-functional. A CRM business process involves the processing of customer knowledge to pursue the goals of relationship marketing. Usually it also involves direct customer contact and the exchange of information or services between enterprise and customer. Such processes are either triggered by the customer (with the aim of receiving information or services), which involves a transfer of information from customer to enterprise, or are triggered by the enterprise with the aim of delivering information or services to customers. Each process handles a specific business object which distinguishes it from other processes. We identified 6 relevant CRM business processes: *campaign management*, *lead management*, *offer management*, *contract management*, *complaint management*, and *service management*.

In contrast to transaction marketing, relationship marketing is based on interactive, individualized contacts [15, p. 11]. *Campaign management* is the core marketing process which implements the ideas of relationship marketing. We define it as the planning, realization, control and monitoring of marketing activities towards known recipients, who are either existing or prospective customers. Marketing campaigns are individualized (one-to-one marketing [31]) or segment-specific, usually use different communication channels, and offer at least one communication channel for feedback from the recipients to allow interaction. Campaigns may be triggered by the enterprise or by the customer. The objective of campaign management is to generate valuable opportunities or “leads” which can be further qualified by *lead management*. An earlier approach which focuses on one-way communication from enterprise to customer is the concept of direct marketing [26].

*Lead management* is the consolidation, qualification, and prioritization of contacts with prospective customers. Contacts may be received from *campaign management* or other sources, e.g. the *service management* process. The objective is to provide sales staff with a qualified and prioritized list of presumably valuable prospective customers to allow a precise and effective address within the offer management process.

*Offer management* is the core sales process. Its objective is the corporation-wide consistent creation and delivery of individualized, binding offers which fulfill all requirements for direct conclusion. An offer management process may be triggered by a customer inquiry, a qualified lead, or an otherwise discovered opportunity.

*Contract management* is the creation and maintenance of contracts for the supply of a product or service. As such,

it may support *offer management* or *service management* processes in the preparation of an offer. Especially important in the service sector, contract management comprises the maintenance and adjustment of long-term contracts, e.g. for outsourcing agreements or insurances.

Within the scope of *complaint management*, articulated dissatisfaction of customers is received, processed, and communicated into the enterprise [41]. The objectives are to improve customer satisfaction in the short-run by directly addressing problems that led to complaints, and to feed a continuous improvement process to avoid complaints in the long-run.

*Service management* is the planning, realization and control of measures for the provision of services. A service is an intangible output of an enterprise generated with direct involvement of customers or some of their assets. Examples include maintenance, repair, and support activities in the after-sales phase as well as the provision of financial or telecommunication services after the conclusion of contracts.

### 3.1.2 CRM activities

In addition to CRM business processes, CRM requires activities to design interfaces to customers at customer interaction points.

*Interaction management* is the analysis and selection of media-based communication channels, e.g. interactive voice response (IVR) or the world-wide-web (WWW), to achieve the optimal channel mix [38]. The objective is to increase the quality and value of interactions while at the same time decreasing the cost of interactions by shifting customers to less costly channels, e.g. web-self-service.

Closely connected to interaction management is *channel management* which addresses the challenge of configuration and synchronization of different communication channels [14]. Key objectives are to define organizational responsibilities for each channel, to avoid conflicts between channels, and to ensure consistent knowledge flows over different channels.

### 3.1.3 Enabling factors

*Opportunity management* has an outstanding role in the context of CRM. In contrast to the rigid structure of processes like e.g. *lead management* which prioritizes valuable contacts derived mainly from *campaign management*, the aim of *opportunity management* is to realize specific opportunities discovered locally by sales and service staff [2]. This can be achieved by the expansion of competences of employees with direct customer contact and the provision of techniques and simple rules for identification and selection of promising opportunities [10].

## 3.2 A customer oriented KM (cKM) model for CRM

In the conclusion of chapter 2.2 we stated that the endorsement of knowledge with an inherent value is the main reason that many KM models have difficulties to prove the value of managing knowledge within a business

environment. The following chapter offers a way to realign a KM model directly to a business process, in this case the CRM process framework of chapter 3.1.

### 3.2.1 Knowledge requirements of CRM

To achieve their goal of serving the customer the individuals performing in CRM must understand and address the customer's processes [29]. They therefore require three different types of customer oriented knowledge:

- They need to understand the requirements of customers in order to address them. This is referred to as “knowledge about customers”.
- Customer needs must be matched with the services and products available. All knowledge required here for can be summarized under the term “knowledge for customers”.
- Finally customers gain many experiences and insights when utilizing a product or service. This knowledge is valuable as it can be used for service and product enhancements. This “knowledge from customers” must be channeled back into an enterprise.

All three types of customer oriented knowledge will be henceforth summarized under the term “customer knowledge”. A cKM model addressing CRM requirements focus on managing customer knowledge. All other knowledge is therefore neglected in the model.

### 3.2.2 Building a customer oriented cKM model

Knowledge is created, located and captured, disseminated, modified and used constantly within all CRM business processes. However CRM does not require self-oriented knowledge management processes. It requires goals for managing the knowledge critical for its business processes.

The cKM model therefore transforms the KM process perspective of ontological KM models into a KM goal perspective. The KM goal perspective offers process owners different options to focus on when managing critical knowledge entities. The cKM goal perspective encompasses four goals (see figure 1):



Figure 1: Knowledge Management Pyramid

- The goal of knowledge transparency supports the execution of business processes in defining their requirements concerning the manageability of customer knowledge. A high degree of manageability requires a high degree of transparency.
- The goal of knowledge dissemination supports the business process owners in defining the degree of customer knowledge distribution required between all individuals that take part in process activities. The management of dissemination requires the management of knowledge transparency.
- The goal of knowledge development supports the business process in defining the requirements concerning the adaptation and creation of knowledge. Even so knowledge can be created by an individual based solely on his or her own context, valuable customer knowledge development from a CRM process perspective requires the ability to disseminate knowledge between individuals. The management of knowledge development therefore requires the management of knowledge dissemination.
- The goal of knowledge efficiency is based on the diminishing marginal utility of customer knowledge. The goal of knowledge efficiency supports the business process in selecting the knowledge crucial for the CRM process from the large body of knowledge available. Knowledge efficiency requires the manageability of knowledge development, because it necessitates a high level of understanding of current and future customer needs essential for enhancing the CRM processes. To voluntarily destroy or disregard customer knowledge, based on the understanding that this knowledge will actually hinder the knowledge flows within a business process, is one of the most difficult managerial decisions, because it requires a decisive decision within an uncertain environment.

The four management goals constitute a cascading framework for analyzing the customer knowledge requirements of a CRM business process. The first three can be compared to the process perspectives of existing KM models such as [43]. Most importantly the KM goals are stripped of their self orientation; they do not add value by themselves but serve as a subsystem for business processes.

### 3.2.3 Managing four aspects of knowledge

While allowing process owners the direct articulation of their knowledge needs, the four KM goals do not provide guidelines for managing customer knowledge based on its relevant characteristics and additional relations. The cKM model therefore is enhanced through the integration four aspects *content*, *competence*, *collaboration* and *composition* as shown in this chapter.

Relevant *aspects* of knowledge can be extracted by

analyzing existing KM models that focus on explaining characteristics and relations of knowledge entities. As shown in chapter 2.2 most KM models fall into this category. The relevance of a knowledge aspect for a CRM process is subject to the following preconditions:

- A knowledge aspect must be of business significance; changes in its parameter values must impact either the cost or the revenues of the CRM process.
- A knowledge aspect must be measurable and manageable within a business process.
- An additional knowledge aspect must form a consistent framework with already chosen aspects; there should be no overlapping in characteristics or dimensions.

Though the number of aspects integrated in a KM model must be based on all relevant aspects, the cKM model described in this paper is based on the action-research results of the CC CKM. As a complete derivation is beyond this paper, we show the basic elements based on an analysis of the SECI model of Nonaka / Takeuchi [27].

This choice is based on the following criteria:

- The model is widely accepted both in the scientific community and the business environment.
- It possesses a “simple” structure, offering one epistemological and one ontological knowledge aspect. Both are well defined.
- The parameter values of its epistemology and its ontology have high a high degree of overlap with the empirical findings.

As described in chapter 2.2, SECI is basically an autopoietic epistemological KM model, focusing on the knowledge aspects of implicit and explicit knowledge. The scientific foundation for this characteristic was published by Polanyi in 1968 [32]. According to Polanyi each individual possesses an amount of implicit knowledge which influences the ability to articulate and therefore explicate and also create knowledge. In the SECI model the difficulty of articulation differentiates implicit from explicit knowledge. Both knowledge entities only exist within an individual. While media, such as text or images, can be used to store and carry their essence in a way, the carried knowledge can only be reconstructed via informational processing through another individual.

The individuals accountable of a business process use both implicit and explicit knowledge to perform their tasks. In addition a business process includes explicated knowledge, mostly in terms of documents, which exists independent of individuals. A process manager is therefore not so much interested in the difference between explicit and implicit knowledge in an individual, a factor that is beyond his control, but in the ratio between explicated and explicit/implicit knowledge, that offers high business performance and adaptability in case of personnel changes while fulfilling external requirements such as financial audits. The process owner can therefore manage the amount of explicated knowledge, henceforth termed the knowledge aspect of “content” as compared to the amount

of explicit and implicit knowledge available in individuals, henceforth termed the knowledge aspect of “competence”.

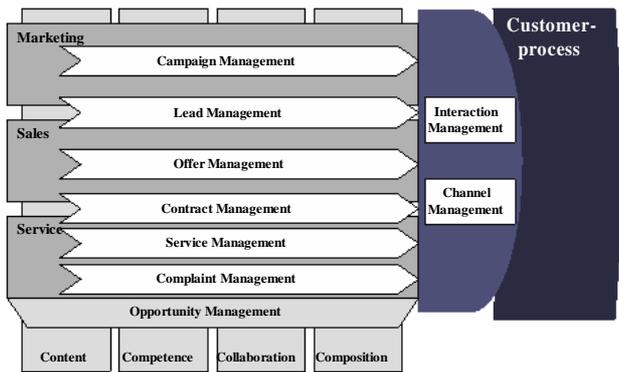
The epistemological view of the SECI models was enhanced through the integration of an ontological agent dimension by Nonaka and Hedlund [20]. The agent dimension describes the possibilities of knowledge dissemination by the four parameter values: individual, group, organization and inter-organization. These parameter values are based on the view of a commercial organization. From a CRM process perspective, only two of these parameter values are of interest. Process interaction with customer focus always includes at least two partners, a service provider and a customer; personal knowledge management is therefore only interesting in terms of sharing knowledge in the process context. From a process perspective there is also no differentiation between an intra-organizational and an inter-organizational process. This leaves the parameter values group and organization. The parameter group represents the dissemination of knowledge between few individuals, henceforth represented by the knowledge aspect of “collaboration”. The parameter value of organization represents the knowledge dissemination between a large number of individuals, henceforth termed as knowledge aspect “composition”. The latter term describes the level of structuring required to relay knowledge, such as this paper, to a large group of individuals. Both knowledge aspects are important for a CRM process, as the cost of dissemination through composition is much more expensive than through collaboration. Also collaboration offers the possibility of relaying implicit knowledge which is not possible through composition.

### 3.2.4 Summary

The cKM model described in this chapter offers goals and aspects of knowledge, that support the management of knowledge within a business environment. The four knowledge aspects of content, competence, collaboration and composition allow the management of knowledge based on the characteristics and dimensions with direct impact to the process performance.

## 3.3 Towards Customer Knowledge Management

We observe in practice that customer relationship management and knowledge management have an considerable synergy potential (see figure 2). While KM acts as a service provider for CRM, the interdependences and mutual benefits between the two approaches result in a merger of equals. The subjoining of knowledge management elements allows CRM to broaden from its mechanistic, technology driven and data oriented approach, enabling it to encompass both the elements of technology and people orientation. Knowledge management is thereby able to prove its value directly within the process chain.



**Figure 2: Customer Knowledge Management model**

As integration area we have chosen the process dimension. Because most CRM and KM research does not directly focus on the process dimension, we stated the modification required to allow a direct integration into a process framework. The following chapter gives a brief overview of a joint model, balancing the approaches of knowledge management and customer relationship management.

### 3.3.1 CRM, customer knowledge and knowledge goals

As described in chapter 3.2.1, CRM manages knowledge for, from and about the customer, a customer lock-in through superior services and products.

Knowledge *for* customers is mainly generated in processes within the enterprise, such as research and development and production. Campaign management is responsible for collecting this knowledge and refining it according to the customer requirements. It is then distributed to the other CRM processes, mainly offer management, contract management and service management. CRM manages knowledge transparency and dissemination of knowledge for customers. Maintaining the balance between comprehensibility and precision is the main challenge when managing this kind of knowledge.

Knowledge *about* customers is captured mainly by offer management, service management, complaint management and, if available, contract management. Main user processes of knowledge about the customer are campaign management and service management, because both processes personalize their services based on user criteria. Knowledge about the customer must be transparent within the company, however its dissemination beyond the border of an organization must be controlled, as knowledge about the customer can often be directly transformed into competitive advantages. The development of such knowledge is also expensive, because knowledge explication is taking time and attention away from the main task, i.e. serving the customer. Interaction management offers possibilities of gaining knowledge about customers automatically via electronic media. The question of how much data about the customer an enterprise can transform into knowledge is the critical challenge when managing knowledge about the customer.

Knowledge *from* customers can be captured in similar ways as knowledge about customers. Gaining knowledge

from customers is based on the fact, that customers gain their own expertise while using a product or service and can be seen as equal partners, when discussing changes or improvements. This aim is not commonly understood in the business world and its impacts poorly researched in academia [13]. To utilize this knowledge from “outside experts” as change agent it must be channeled into the back end processes of an enterprise, such as the research and development process. Even so valuable knowledge from customers is mostly gained at the service points, an enterprise must check its CRM processes for their capability of serving customers. To bend CRM away from their service goal in order to capture higher amounts of knowledge from customers is a short sighted goal.

### 3.3.2 Knowledge aspects and the enabling factor

The knowledge aspects support CRM in maintaining its primary goal of service for customers, by managing knowledge for, about and from customers. The management of content allows CRM process owners focus on the messages they want to deliver to customers. Competence management streamlines processes, as it bridges the gap between an individual receiving a customer request and the individual solving it. Collaboration support allows teamwork with less time and space constraints. Composition enables scaling the former three beyond the team context, as structures and indexes allow faster access to knowledge by navigation and search.

### 3.3.3 Summary

As shown, the integration of CRM and KM approaches benefits the utilization in both areas. While the CKM model displays the major integration elements, the performance benefits of the integrated approach however can only be shown in specific process implementations.

## 4. Enhancing knowledge dissemination in a customer service center

The following excerpt of a action research case of a large fund managing bank (LFMB) shows the business impact of the CKM view in a typical CRM environment. The case focuses on a major element within modern CRM concepts, the call or communication centers (CCC), that in many companies consolidate the communication channels phone, fax and email serving a geographically dispersed client base.

### 4.1 Large Fund Managing Bank (LFMB)

Founded by 14 private banks in 1956, our research partner LFMB offers specialized funds for private and institutional investors. In December 1999, the company moved up to the top three players of the German fund market managing assets of EUR54bn.

Because our research partner primarily works as specialized service provider for the founding banks, the CCC serves bank employees and retail customers alike. This requires a profound knowledge of the banking and funds

environment. The CCC employees possess a high expertise in their chosen profession, many of them having specialized degrees and multiple years of working experience within the banking environment.

The CCC consists of 120 employees, two thirds offering the more general first level support while one third specializes in second level support on complicated and dynamic knowledge areas such as funds in specific international area.

#### 4.2 KM challenges of customer service

In order to address their customer needs, CCC employees utilize different information sources. News and important information concerning services and products are provided by an internal unit named information management (IM). This content is still mostly disseminated via email. While this is possible without investments into the technical infrastructure, each CCC employee must organize his or her content individually and new employees have no knowledge base to build on. The amount of content disseminated also strains the network environment as the usual informational email includes frequently 10 up to megabytes of attachments and thus its transfer via simple mail transfer protocol (SMTP) to nearly 150 recipients results in a data transfer volume of up to 1.5 gigabytes for one email.

IM therefore started implementing a new information channel using basic web technology. The resulting intranet presence, termed "surfMe", is intended to be a centralized platform offering information about products and services that can be used by CCC employees when serving customers on the phone.

After one year in service, the role of "surfMe" entered a critical stage. While the amount of content included in the system started to put a strain on maintenance for IM, it still failed to accomplish full acceptance by the CCC employees: Important information was not available instantly and the missing search functions prolonged the critical time to retrieve content when searching for information while serving a customer on the phone.

While thinking about changing the technical infrastructure IM brought up the case within the context of the CC CKM in order to achieve a comprehensive analysis of the challenges hindering the success of the new communication channel.

#### 4.3 Relevant knowledge goals and aspects

Based on two one-day workshops, the CKM model was used to analyze the success factors for redesigning the existing communication channels based on LFMB's customer knowledge processes.

The focus of the project was to provide the CCC employee with knowledge for the customer. Because many members of IM were former CCC employees, IM has a very good overview of the knowledge available and required by the CCC; knowledge transparency therefore was not an issue. The main knowledge goal of the project was enhancement of knowledge dissemination. A follow-up

with knowledge development was also seen as important, as most knowledge used within CCC is created in other departments such as product management and marketing. Because knowledge delivering to the CCC-employees, working to solve this challenge was delayed until the basic solution for dissemination was operative.

After determining the knowledge goals, relevant knowledge aspects and its manifestations were identified. The demands of the CCC employees showed a major shortcoming in the current design of knowledge *composition*. The navigational structure was unwieldy, searching for content was not possible.

IM itself required improvement on the knowledge aspects of content and composition. The major content challenge, requiring up to 50% percent of the time spent for "surfMe", was identified in the transformation of documentation from MS office format delivered by other departments into content displayable in a web browser. The composition challenge matches with the requirements of CCC. The constant growth of the "surfMe"-structure required increasing maintenance and tied employees to their job roles as web managers, as assigning new colleagues became increasingly expensive. Even though it was not in the original focus, the possibilities of adding the knowledge aspect of competence via an expertise directory was discussed during a workshop. Foundations of this knowledge aspect already existed within the electronic phone books offered by "surfMe" that serves as a rudimentary yellow pages system.

#### 4.4 Results

Through the use of the CKM model as analyzing tool, relevant weaknesses of the current knowledge management configuration could be identified and communicated in a structured and coherent way. This led to a customer and maintenance friendly architecture for the new application, which was tested in a rapid prototype. The resulting reengineering project for "surfMe" concentrated on the removal of the identified weaknesses, which had a profound impact on the requirements specification for the new technical solution, namely stating flexible transformation of office documents into HTML (rendering), in place editing of documents on the server, an automatic maintaining search indexer and a navigational bar that can be managed by editors as mandatory features. Similar results were obtained in projects with other research partners.

### 5. Summary and outlook

We observed in multiple cases [21], that management of knowledge is a critical success factor for CRM. Knowledge management methods with the aim of supporting CRM have to be process-oriented.

Based on literature and action research, we tried to show, that CRM and KM have high synergy potential and should be used in conjunction. To achieve a good integration we proposed a business process model for CRM comprising six relevant business processes: campaign management, lead management, offer management, con-

tract management, service management, and complaint management. Additional activities for the implementation of the customer interface are interaction management and channel management. We identify four relevant knowledge aspects: content, competence, collaboration, and composition to supplement the CRM processes. These aspects allow a structured approach for the identification of opportunities for business process improvement by KM.

On reflection, the proposed business process model for CRM provides an initial point for the process-oriented application of KM. However, it has insufficient granularity to allow a thorough analysis of potentials for process optimization by KM. The four knowledge aspects provide guidance in the discovery of optimization potentials. They do not replace a method for process-oriented KM, but form the foundation for such a method subject to further research.

To address the mentioned shortcomings, we will advance and detail the CRM process model so that it describes knowledge flows among the processes. Furthermore work on a method for Customer Knowledge Management which aims at using the four knowledge aspects to improve the CRM processes is underway.

The main focus will be the measurement and proof of tangible performance improvements achieved.

## References

- [1] Boisot, M. *Information and Organisations: The Manager as Anthropologist*, Fontana / Collins, 1987.
- [2] Colarelli O'Connor, G. & Rice, M. P. "Opportunity Recognition and Breakthrough Innovation in Large Established Firms", *California Management Review*, 2001, 2(43), 95-116.
- [3] Davenport, T. H. *Process Innovation: Reengineering Work Through Information Technology*, Harvard Business School Press, 1993.
- [4] Davenport, T. H., Harris, J. G. & Kohli, A. K. "How Do They Know Their Customers So Well?", *MIT Sloan Management Review*, 2001, 2(42), 63-73.
- [5] Davenport, T. H. & Marchand, D., "Is KM just good information management?", *Financial Post*, 04/24/2001.
- [6] Day, G. S. *Capabilities for Forging Customer Relationships*, Research Report, Marketing Science Institute, Cambridge, MA, 2000.
- [7] Demarest, M. *Knowledge Management: An Introduction*, <http://www.hevanet.com/demarest/marc/km1.pdf>, 27.09.2001.
- [8] Donahue, K. "Knowledge Management: Beyond Databases", *Harvard Business Management Update*, 2001, 5(6),
- [9] Drucker, P. F. "Knowledge Worker Productivity - The Biggest Challenge", *California Management Review*, 1999, 2(41), 79-94.
- [10] Eisenhardt, K. M. & Sull, D. N. "Management as simple Rules", *Havard Business Review*, 2001, January(79), 107-116.
- [11] Enkel, E., et al. *MERLIN - Materializing, Experience, Refining and Learning in Knowledge Networks*, Research Report, Institute of Information Management, University of St. Gallen, St. Gallen, 2000.
- [12] Eppler, M., Seifried, P. & Röpneck, A. "Improving Knowledge Intensive Processes Through an Enterprise Knowledge Medium", Proceedings, *SIGCPR*, New Orleans, 1999,
- [13] Garcia-Murillo, M. & Annabi, H. "Customer knowledge management", *Journal of the Operational Research Society*, 2002, 53), 875-884.
- [14] Gronover, S. & Riempp, G. "Kundenprozessorientiertes Multi-Channel-Management", *ioManagement*, 2001, 4(25-31).
- [15] Grönroos, C. "From Marketing Mix to Relationship Marketing: Towards a Paradigm Shift in Marketing", *Management Decision*, 1994, 2(32), pp. 4-20.
- [16] Gruber, T. R. *A Translation Approach to Portable Ontology Specifications*, Research Report, Knowledge Systems Laboratory, Stanford, 1993.
- [17] Gummesson, E. *Qualitative methods in management research*, 2nd ed., Sage Publications India, 2000.
- [18] Hammer, M. & Champy, J. *Reengineering the Corporation*, Harper Business, 1993.
- [19] Harrington, H. J. *Business Process Improvement*, McGraw-Hill, 1991.
- [20] Hedlund, G. & Nonaka, I. "Models of knowledge management in the West and Japan", in: *Implementing Strategic Processes, Change, Learning and Cooperation*, eds.: Lorange, B., et al., Macmillan, 1993.
- [21] Kolbe, L., Brenner, W. & Österle, H. *Customer Knowledge Management in der Praxis*, Springer, 2003.
- [22] Levitt, T. "After the Sale is Over", *Harvard Business Review*, 1983, 5(63), 87-93.
- [23] Martensson, M. "A critical review on knowledge management as a management tool", *Journal of Knowledge Management*, 2000, 3(4), 204-216.
- [24] McAdam, R. & McCreedy, S. "A critical review of knowledge management models", *The Learning Organization*, 1999, 3(6), 91-100.
- [25] McLoughlin, H. & Thorpe, R. "Action learning - a paradigm in emergence: the problems facing a challenge to traditional management education and development", *British Journal of Management*, 1993, Vol 4), 19-27.
- [26] Nash, E. *Direct Marketing*, McGraw-Hill, 1986.
- [27] Nonaka, I. & Konno, N. "The concept of "Ba": Building a Foundation for Knowledge Creation", *California Management Review*, 1998, 3(40), 40-55.
- [28] Österle, H. *Business in the Information Age: Heading for New Processes*, Springer, 1995.
- [29] Österle, H. "Enterprise in the Information Age", in: *Business Networking: Shaping Collaboration Between Enterprises*, eds.: Österle, H., et al., Springer, 2001.
- [30] Parvatiyar, A. & Sheth, J. N. "The Domain and Conceptual Foundations of Relationship Marketing", in:

- Handbook of Relationship Marketing*, eds.: Sheth, J. N. & Parvatiyar, A., Sage Publications, 2000.
- [31] Peppers, D. & Rogers, M. *The One to One Future: Building Relationship One Customer at a Time*, Currency/Doubleday, 1993.
- [32] Polanyi, M. *The Tacit Dimension*, Routledge & Kegan Paul, 1966.
- [33] Porter, M. *Competitive advantage: creating and sustaining superior performance*, Campus, 1985.
- [34] Probst, G. J. B., et al. "Managing Knowledge: Building Blocks for Success", in: eds.:, John Wiley & Sons, 1999.
- [35] Schmid, R. *Eine Architektur für Customer Relationship Management und Prozessportale bei Banken*, Dissertation, University of St. Gallen, St. Gallen, 2001.
- [36] Schulze, J., et al. "Knowledge Enabled Customer Relationship Management", in: *Business Networking: Shaping Enterprise Relationships on the Internet*, eds.: Österle, H., et al., Springer, 2000.
- [37] Schwede, S. "Vision and Reality of CRM", *Information Management & Consulting*, 2000, 1(15), pp. 7-11.
- [38] Senger, E., Gronover, S. & Riempp, G. "Customer Web Interaction", Proceedings, *Conference on ...??*, Dallas, 2002,
- [39] Shani, D. & Chalasani, S. "Exploiting niches using relationship marketing", *The Journal of Consumer Marketing*, 1992, 3(9), pp. 33-42.
- [40] Shaw, R. *Measuring and Valuing Customer Relationships*, Business Intelligence, 1999.
- [41] Stauss, B. & Seidel, W. *Beschwerdemanagement: Fehler vermeiden - Leistung verbessern - Kunden binden*, Hanser, 1998.
- [42] von Foerster, H. "Principles of self-organization in socio-managerial context", in: *Self-organization and Management of Social Systems*, eds.: Ulrich, H. & Probst, G. J. B., Springer-Verlag, 1984.
- [43] von Krogh, G., Nonaka, I. & Aben, M. *Steps to a Knowledge Strategy*, Research Report, University of St. Gallen, St. Gallen, 1999.
- [44] von Krogh, G. & Roos, J. "An essay on corporate epistemology", *Strategic Management Journal*, 1994, 15), 53-71.
- [45] Watzlawick, P., Beavin, J. H. & Jackson, D. D. *Pragmatics of Human Communication : A Study of Interactional Patterns, Pathologies, and Paradoxes*, W. W. Norton & Company Inc., 1967.
- [46] Wenger, E. *Communities of Practice: Learning, Meaning, and Identity*, Cambridge University Press, 1997.
- [47] Wiig, K. *Knowledge Management A Triology - Volume 3. Knowledge Management Methods: Practical Approaches to Managing Knowledge*, Schema Press, 1995.

# How to Transition from a Traditional to an E-Business Enabled Real Estate Agency

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## Abstract

A framework is developed to enable transition from a typical real estate agency towards an e-business enabled business environment, based on an agency configuration located in Townsville, Australia. This transition is modeled according to a number of stages. In the strategic audit stage, a TOWS matrix is suggested which combines Porter's Five Forces Model of Competition, adapted with a SWOT analysis. The next stage of an e-business case development for this real estate setting differentiates among inside partners, nearside partners, and external partners. Stage three states the composition of the systems analysis team, whereas in stage four the system architecture and infrastructure are specified, including a number of relevant legislative issues. Subsequently, the web interface design-stage is elaborated on, including accessing issues by different user groups. Two extreme examples of customer interfacing are presented to illustrate the need for the interface to be flexible, information gathering, and execution focused. These four stages summarize the transition process real estate agencies may work through to become fully e-business enabled.

## 1. Introduction

Real estate in Australia has been slow to embrace e-business. Without a direct and immediate impact on revenues, some entrepreneurial businesses have trouble justifying the expenditure. Others, viewing real estate as a "people" business, consider e-business a hindrance to relationships. Still others cite the idiosyncratic nature of real estate transactions and portfolios, the difficulty of adapting off-the-shelf software to meet their specific requirements and the high cost of custom programming [2].

It is our belief that real estate management may not have a good grasp of what a total e-business solution has to offer in today's real estate environment, and moreover, not a clear picture of how to progress from a "traditional" (albeit basic Web-supported) business setup towards an e-business enabled configuration. This paper attempts to address this very issue, and presents a framework for

making this transition a reality, while illustrating how e-business enabled real estate interactions and transactions could enhance business and create new opportunities. This framework is applied to a real estate business in Townsville, Australia; which, for confidentiality purposes, is referred to as company XYZ in the remainder of the paper.

## 2. Local Industry Environment

With the current trend to smaller families, people remaining single longer and the ageing population, there will be an ongoing need for residential accommodation and commercial business to service the population as it grows.

Townsville, North Queensland, in Australia enjoys a broad economic base which is underpinned by manufacturing, government administration, defense, port facilities, extensive educational facilities, a stable and ever increasing tourist industry, and a large self supporting retail sector.

Townsville and environs count in excess of 60 real estate agencies. Of these, at least 9 belong to major national and international franchise groups including L.J. Hooker, Century 21, Knight Frank and Ray White. In addition to the real estate firms, there are the residential land developers who provide about 900 newly developed blocks each year to service the Townsville market. The real estate firms also play a part in selling the residential land on behalf of the developers.

A further subset is the building industry which builds spec homes that the agents are engaged to sell. This generally results in a flow-on effect when the new home buyer looks to vacate the existing family home by selling it through an agent, and so the circle continues.

The real estate industry in each state has its representative body in the various Institutes, such as the Real Estate Institute of Queensland (REIQ) in Queensland. These disparate bodies tend to work independently of each other, and of the national body, the Australian Real Estate Institute. As a result, there are varying policies and procedures that make it difficult for agencies to reconcile. An example is the variety of key principles and guidelines that have been developed to accord with changes to the Australian Privacy Act.

Company XYZ consists of four offices, employing 25 staff. Each of the offices has an administrative officer who is responsible for day-to-day activities, receiving and redirecting inquiries, attending to agents needs and the preparation of sales documentation. In addition, there is a central administration manager who attends to the "business" of the business, that is payroll, financial management and maintenance of the rent roll.

The real estate wing of the value chain has a marketing manager who works with agents and the clients to ensure that the properties are featured in such a way as to gain maximum exposure and have maximum potential for sale. The marketing manager has graphic design and copy writing skills that are used in advertising and promotion of both the real estate business and the properties it represents.

A manager oversees the operations of the four offices, aided by an administrative assistant responsible for tasks such as preparation of routine correspondence, travel arrangements, appointments, compilation of statistical data for reporting and follow-up. A sales force of 17 real estate agents, directly accountable to the manager, completes the staffing requirement.

All sales people are employed under Australian Workplace Agreements that guarantee them a retainer and a share in the commission structure. Commission is charged to clients in accordance with the recommendations of the REIQ (5% of the first \$18,000 and 2.5% of the balance of the gross sales price for residential properties). Generally, negotiations take place on commercial property sales which can equate to between 1% and 2% on the gross sales price. The Principal of the company XYZ pays agents a 30% share of the normal commission, 20% on commercial sales, and negotiates commission on major commercial and industrial sales in excess of \$500,000. The company generally resists negotiating away the standard REIQ commission rate with residential vendors so as to maintain consistency.

In addition, there are unique share arrangements with land developers and builders, negotiated on an individual basis. The company 'conjuncts' on commission when a listed property is sold by another agency, and expects the same in return when it sells a property listed by another agency. The business also retains a rent roll.

A proposed organizational structure is shown below.

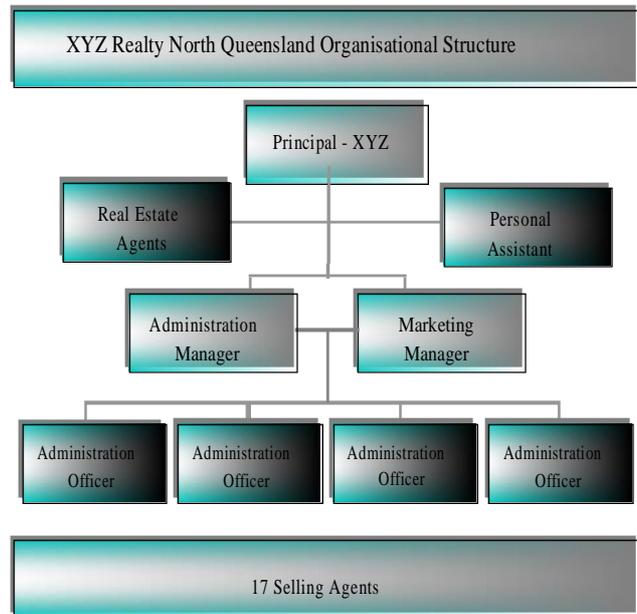


Fig 1: Company XYZ: organizational structure

XYZ currently services the residential market through the sale of existing houses, builders spec houses and its property management services. It also specializes in commercial and industrial property and vacant land sales on behalf of the developers. Initially, XYZ was established primarily on a platform of residential house sales that provided the majority of the revenue to the business, particularly in the early establishment phase. Moreover, Townsville is home to some 10,000 military personnel who are housed generally in rental accommodation owned by the Defence Housing Authority (DHA), or leased by the DHA from private owners. XYZ is one of a number of real estate agencies which provides real estate services to the DHA.

A natural extension to the residential unit was commercial sales, where more particular expertise is required to enable an understanding of turnover-, value-, and potential-issues, leading towards the hiring of specialist agents in this area on the sales team.

In addition to the above revenue streams, XYZ has a rent roll of some 1,000 properties. This is managed primarily by the Principal, with the assistance of the office manager, who undertakes the day-do-day administrative functions, inspections and maintenance arrangements. XYZ realizes a 7.5% management fee on all rental payments, as well as a commission fee for the arrangement of maintenance services to the properties. XYZ is also the managing agent for two neighbourhood shopping centres in Townsville, for which a management fee is paid, based on a percentage of tenancy rent.

XYZ is looking at further expanding its business into areas such as entrepreneurial activities, project management, financial planning and lending services to complement the current business activities.

### 3. Transitional Framework

#### 3.1 STAGE 1: Strategic Audit

For this purpose, Porter's Five Forces Model of Competition [10] could be adapted with a SWOT analysis into a TOWS Matrix [9], asking two critical questions: First, what is the structure of the industry, and how is it likely to evolve over time: Second, what is the company's relative position in the industry?

The TOWS Matrix, shown below, is the Threats-Opportunities-Weaknesses-Strengths matrix that enables an organization to assess the best strategies after assessing how the strengths, weaknesses, opportunities and threats relate to each other and how they can be used to highlight areas that need an avoidance strategy and areas that offer advantages. For instance XYZ's decentralized system and geographic spread allows it to serve communities across the Townsville region and take advantage of local neighbourhood opportunities because of its in-situ status. This would fall into the SO Strategies Square.

	<b>Strengths (S)</b> List Strengths (1 Æ 10)	<b>Weaknesses (W)</b> List Weaknesses (1 Æ 10)
<b>Opportunities (O)</b> List Opportunities (1 Æ 10)	<b>SO Strategies</b> Use Strengths to take advantage of Opportunities	<b>WO Strategies</b> Overcome Weaknesses by taking advantage of Opportunities
<b>Threats (T)</b> List Threats (1 Æ 10)	<b>ST Strategies</b> Use Strengths to avoid Threats	<b>WT Strategies</b> Minimize Weaknesses to avoid Threats

Fig 2: Company XYZ : TOWS matrix structure (source: Miller, A., 1998)

This results in the preparation of a blueprint that maps out where the company is going over the next five years. Underpinning the strategic plan must be a business plan which details the operational allocation for the activities

planned for the next year including goals, objectives, financial allocation, key performance measures and projected outcomes. In addition, monthly short-term plans are developed for company reporting, including sales figures, listings and financial performance.

Strategic information systems can be viewed as one of four types in a step-wise progression [11]:

Step 1: Those that share information via technology based systems with customers/consumers/ and/or suppliers and change the nature of the relationship.

Step 2: Those that produce more effective integration of the use of information in the organization's value adding process.

Step 3: Those that enable the organization to develop, produce, market and deliver new or enhanced products or services based on information.

Step 4: Those that provide executive management with information to support the development and implementation of strategy (in particular, where relevant external and internal information were integrated in analysis).

The move towards an e-business enabled agency can therefore be seen as a progression to step 3, and eventually step 4 in the information systems strategy.

#### 3.2 STAGE 2: Development Of An E-business Case

An e-Business case must be systematically assembled to enable a clear and concise plan to be formulated from the following questions:

Strategic justification: "Where are we going?"

Operational justification: "How will we get there?"

Technical justification: "When will we get there?"

Financial justification: "Why we will win?"

Collaborative justification: "Who will we be taking with us?"

To successfully create an inter-enterprise community it is necessary to examine the links organizations have with one another, with the strategy for capturing electronic channels [8].

The methodology includes the following steps:

Define power relationships among the various players and stakeholders.

Map out the extended enterprise to include suppliers, buyers and strategic partners.

Plan the electronic channels to deliver the information component of products and services.

The discussion of how to gain power raises two important questions:

How might alliances with other firms across industries or even with competitors help us?

How do we need to restructure ourselves to seize the opportunity or ward off a threat?

Participants in the inter-enterprise organization of Company XYZ are shown in Figure 3 below:

Inside Partners	Nearside Partners	Network Partners
Information Technology Providers Agents Administrative Staff Management	Buyers Sellers Landlords Tenants Solicitors Conveyancers Real Estate Agents Purchasers' Financial Institutions Vendors' Financial Institutions	Councils Land Titles Office Office of State Revenue Other Government Departments (eg. Main Roads, Contaminated Sites Registry) Insurers Telephone Companies Electricity Companies Newspaper Delivery Army housing etc.

Fig 3: Partners of collaborative inter-enterprise organization of company XYZ

These strategic partners are classified as inside partners, nearside partners, and network partners [1]:

Inside partners; those required for the development and support of the business plan.

Nearside partners; those that will assist in the tactical implementation.

Network partners; that will assist and enable the business model but will not require close day-to-day or strategic coordination

Each of these partnerships is elaborated on next:

### 3.2.1 Inside Partners – systems architecture

These partners are sourced for building or modifying the architecture required to create an e-business extended enterprise for the real estate agency. Issues that need to be explored when choosing this partner include:

Experience – how many marketplaces have they built so far, what is the transaction flow through those marketplaces, how do they compare to what company XYZ is intending to build?

Ownership – What is the company structure? Can XYZ buy into the partner company, giving them an equity position and a say in the future direction and management of company XYZ?

Cost – what is the total cost? XYZ-benchmarks need to be set, and limits of exposure established, so that the expense doesn't spiral out of control.

Integration – the new marketplace needs to be fully integrated into the other applications within the company,

such as any legacy systems, and new off-the-shelf applications [3].

### 3.2.2 Nearside Partners - The Selling Process

Nearside partners in the real estate selling process are financiers, conveyancers, and valuers. By integrating the processes and workflows of these partners, XYZ can provide a faster and more efficient service to customers. For example, when a sales agent executes a sales contract, a workflow is generated for the conveyancers to conduct a title search on the property. This title search is raised only once, and is stored online so that it can be 'shared' by all three parties. Currently, all three would conduct their own search independently of one another, and pass on the cost to the customer. (\$12.60 per search). Using EDI, each of the partners can access and use a secure section of the system to post and track information required to complete the transaction. By combining and coordinating all the aspects of the process, a more efficient and cost effective customer delivery channel is created. Savings from these synergies can be treated as a benefit to the individual partners bottom line, or used to generate increased market share through packaged incentives, such as a finance/conveyance package.

### 3.2.3 Nearside Partners - The Rent Roll

These include trades people, cleaners and general maintenance services, providing services to both landlords and tenants. Landlord and tenants can go online and choose one of the service providers listed, and detail the specific job that is required.

Again, a workflow is created, allocating the job to the required service provider. Payment for the service is coordinated, yielding a commission to XYZ for its involvement. By incorporating the service provider into the workflow management, it enables XYZ to maintain control over supply and the level of the service delivery offered. By providing consistent and effective service delivery to its tenants and landlords, XYZ creates customer loyalty.

An integrated CRM system collates the data of services used, and prompts future potential business. For example, twelve months ago a landlord used one of XYZ maintenance services to clean the gutters on their rental property. The CRM system raises an event notification that sends an automated response letter to the landlord asking if they would like XYZ to arrange to have the gutters cleaned again. The letter requests the landlord to either log in on XYZ's secure web site, or call a customer service representative. The landlord is pleased at the level of service, the service partner is happy for the additional work, and XYZ has generated some additional revenue.

### 3.2.4 Network Partners – External Support

Network partners include organizations, such as the local authority and other statutory bodies involved in the

industry, i.e. the urban land development committee, media and industry associations, and the like.

After partners have been selected, a program of ongoing measurement needs to be developed to ensure that the partnership is the best possible for the desired outcome, and that all partners are embracing the common goals of the alliance.

### 3.3 STAGE 3: Systems Analysis Team

Company XYZ's systems analysis team consists of:

The principal (to keep the all on task and focused on desired company directions)

The administration manager (for practical advice and input in relation to the historical operation of the business)

The marketing manager (to sell the product to strategic partners, both during the development and implementation phases)

A senior sales agent (to provide input from their field experiences)

An IT consultant (to advise on appropriate software, hardware and interactive web site design)

Management consultants (to undertake customer/staff surveys, facilitate focus groups, liaise with preferred strategic partners, facilitate change management and training issues)

A scribe or person (to record all activities of the project meetings)

End-user representation (to provide agent/customer input and feedback)

### 3.4 STAGE 4: System Architecture And Infrastructure

Company XYZ currently operates with independent computer systems located at each of the offices. The systems communicate via email. Financial management is carried out at the main office, with little feedback to the branch offices. Development of systems architecture and infrastructure is required to support the inter-enterprise e-business initiative.

A local area network (LAN) is to be set up between the branch offices, the main office, and participating partners, enabled by ISDN data links to form a wide area network (WAN), and designed to incorporate G3 wireless application protocol (WAP) devices. In the main office, an application server is to be installed. Data sources include:

General public queries on available properties and data requests from strategic partners

Queries and requests of owners of properties managed by XYZ.

Field data and requests from sales agents (through notebook computers, PC's, WAP devices, etc.)

Requests, links, and feedback from government agencies and regulators.

A number of legislative issues, as they relate to XYZ, for future attention and integration into the new e-business enabled platform include:

Retail Shop Leases Act 1994

Residential Tenancies Act 1994

Property Agents and Motor Dealers Act 2000 Code of Conduct

Land Act 1994

Duties Act 2000

Privacy Act 1988

Auctioneers and Agents Act 1971

Electronic Transactions Act 2000

Trust Accounts Act 1973

Property Law Act 1974

Land Titles Act 1994

Land Sales Act 1984

Traffic Infrastructure (Roads) Act 1991

Integrated Planning Act 1997

Fair Trading Regulation 2001

Anti Discrimination Act 1991

XYZ staff must become cognisant of consumer and contract law as it applies to the real estate industry. For example, the company's trade practices and consumer protection responsibilities, issues covered by intellectual property, copyright and patents legislation and its responsibilities in relation to keeping and reporting against a Trust Account, Local Authority regulations regarding services, requirements and charges, such as cost of rates, water and water allocation, and even rubbish collection days.

National Privacy Principles need to be integrated into the new platform. The discussion about privacy essentially encompasses those things that a company can and cannot do with personal information. "Personal Information" is information from which a person can be identified either by use of their name or a description of them or their circumstances.

The Privacy Act regulates the way personal information is handled at all stages. This includes:

How the information is collected

How the information is used

To whom the information is disclosed

How the information is handled and stored

When the information is destroyed

In this context "privacy" is distinguished from security and confidentiality. "Security" relates to the way in which personal information in a system, (either manual or computerize, is protected from misuse and loss and from unauthorized access, modification or disclosure. "Confidentiality" relates to the secrecy afforded to particular information and prevents its disclosure in certain circumstances. Whilst security and confidentiality go hand in hand in protecting information, privacy is broader and covers the whole "information lifecycle".

As was illustrated above, strategic partners operate within a complex legislative structure, which must be adopted across the network of partners.

#### 4. Web Interface Design

The web interface links the real estate customer to the inter-enterprise organization, and is the 'front end' basis of a new e-business model for the company XYZ.

In this context, XYZ must meet specific web design criteria. It must work with its web design project team and develop its initial site design. The QFD model, proposed by Hamilton and Selen, (2002) [4] may provide a starting point for determining the initial design parameters. The web site design incorporates active learning [6] to enhance interest and marketability.

A detailed specification is prepared in consultation with the web designer and the XYZ Systems Analysis Team to ensure that all the criteria are addressed and included.

The XYZ Systems Analysis Team must consider a variety of web related features, including:

- Web Site Design, Site Hosting and Web Metrics
- Network and Database Management
- Training, Support and Site Management
- Web Content Management Solution
- Multi-channel/Systems Integration
- The Customer's Online Experience
- Bulletin Boards and Event Calendars
- Real Estate Listing, Ordering, and Editing
- Maps, GIS and Visuals
- Cost of Mortgage Calculators
- Solicitors, Schools, Medical Facilities, Shops, Community Organizations, Transport, etc
- Relevant Databases
- Finance and Legal Details
- Purchase, Rental, Facility Management and Lease Data
- Allowed Transactions
- Ethics and Security.

The following simple questions will determine if a Web page is well designed:

How quickly does it download?

How easy is it to navigate?

How well does the search work?

How readable is the content?

Is the page and the content uncluttered and appealing?

Real Estate is ideally suited to a daily changing web page, incorporating the movement, addition and deletion of properties for sale; informative articles; and tips and hints to prospective customers. Web page maintenance and continuous updating is an absolute imperative.

Customer needs must be efficiently communicated through multiple integrated channels. XYZ must set up seamless complementary interactions between traditional and e-channels; the telephone, facsimile, face to face, web, email. Channels other than face-to-face are to be seen as facilitators. For example, a client may value the

ability to have a comprehensive description of a property with some photographs available online but this will rarely replace a physical examination of the property. In order to secure sales, XYZ must 'push' clients towards physical visits of properties and completion of sales transactions.

The web interface must seek to use existing relationships to grow revenue, use integrated information from all channels for service excellence, and facilitate the provision of consistent replicable multi-channel processes and procedures.

All of the interfaces (and the systems supporting it) should be totally client focused. A number of access points within the e-business enabled real estate agency are elaborated on below:

##### 4.1 XYZ Main Office Staff Resident Application Server

Administrative staff, sales staff and management in the central office access the application through the LAN and WAN for operating the business and for the purpose of administration, sales and rent roll maintenance.

##### 4.2 XYZ Staff Company Application Server

Administrative staff, sales staff and management in the other three offices access the company application server over the ISDN line for day-to-day needs for operating the business and for the purpose of sales and administration.

##### 4.3 XYZ Staff Remote Application Server

Generally remote access will be undertaken by sales agents from notebook computers to access contract templates for sales, as well as statistical data to assist sales.

##### 4.4 Restricted Access

Some areas would require authentication and only be accessible by a restricted group of users. For example, property owners may be able to access restricted sections of the site to view rent collection, management fee payments and allow them to "order" a service such as plumber or gardener. The system will notify XYZ of the request, which will then be arranged and subsequently charged to the property owner's account with a commission payment for the service to XYZ. Other examples include participants to a conveyance accessing a common conveyance 'file', and updating or retrieving information.

##### 4.5 General Public Access

This is the strategic "face" of the organization, the public part of the company's online presence.

The customer must be able to readily tailor and select services and goods to meet their wants. The authors

recently developed an approach for segmenting markets and development of a dynamic web interface for this purpose [4],[5].

Furthermore, the e-business system allows for product customization, pricing and contract management, quote and proposal generation, appropriate commission agreements and promotion management. These require the interfaces with the client to be flexible, as well as information gathering and execution focused.

It must integrate customer content, contact information, end-to-end business processes, extended enterprises or partners (providing inter-enterprise customer care) and all customer applications (such as telephony). It must be focused towards opportunity creation and tracking [7].

Two extreme examples of possible interface interactions are described as they apply to XYZ:

#### Example 1:

A member of the public is looking for a property in a particular suburb. A click on the suburb will bring up the Graphical Information System (GIS) interface or electronic map that is pre-loaded with all properties available for sale.

The potential customer can then click on social infrastructure find out what parks, schools, churches etc are in the immediate area. The road network layer can be displayed and local shopping centres and other areas of interest.

Once the customer has decided on the area of interest, a click on the GIS locator will display details of properties for sale. For instance, if the area in Smith Street appeals to the customer, a click on the house for sale in that street will result in a photograph of the house being presented on the screen with a drop down box in which the customer can choose to see the price, the size of the land, location of services (sewerage etc) and perhaps a layout plan of the house.

#### Example 2:

If, however, the customer is looking for a house in a certain price range, then a form can be presented with drop down boxes allowing a choice of queries to be entered to match the customer's criteria, e.g. between \$200,000 and \$250,000; three bedrooms with ensuite and double garage. All of the houses in Townsville listed with XYZ and matching those criteria will then be presented for further investigation.

From there the customer can choose a house and retrieve the photograph and details through the GIS interface described above.

As the customer moves from this web-interface area, a screen should be triggered inviting the customer to enter details of name and contact for enable follow-up. This follow-up occurs in a timely manner, such that sales agents take over with the personal touch to provide further information and make inspection arrangements with a view to completing a sale, deploying internet enabled laptops and WAP devices.

## 5. Conclusion

A framework was developed to enable transition from a typical real estate agency towards an e-business enabled business environment, based on an agency configuration located in Townsville, Australia. This transition was modeled according to a number of stages, including a strategic audit, development of an e-business case, the setting up of a systems analysis team, discussion of the system architecture and infrastructure, and finally the Web interface- design .

## References

- [1] Cunningham, M. "B2B, How to Build a Profitable e-Commerce Strategy." Allen and Unwin, (2002).
- [2] Deloitte and Touche. "Real Estate Strategies, First Quarter 2002." World Wide Web page < <http://www.deloitte.com/vc/0,1029,sid%253D2232%2526cid%253D3718,00.html> > (accessed July 1, 2002), pp.1-20.
- [3] Franchitto, M. "Customer Profitability – Is it enough?" Australian Banking & Finance, (March, 2002), p.10.
- [4] Hamilton, J., and Selen, W. "Integrating web site design features for one-on-one marketing: A QFD framework." Proceedings 7<sup>th</sup> International Conference on ISO9000 & TQM, Melbourne, (April, 2002), Business Process Reengineering & QFD Track (CD ROM), pp.331-339.
- [5] Hamilton, J., and Selen, W. "The development of the dynamic web interface between the online e-customer and the e-business." Proceedings 6<sup>th</sup> ANZAM/IFSAM International Conference, Gold Coast, (July, 2002), E-Commerce and Technology Track (CD ROM).
- [6] Hamilton, J. "4th generation innovation approach to IT education: Integration of supply chain, knowledge management and business intelligence with the learning organization." Proceedings International Conference on Business, Hawaii, (June, 2002), IT, IM, & Training Track (CD ROM), p.1-12.
- [7] Inan, H. "Measuring the Success of Your Web Site." Pearson Education, (2002), pp.209-225.
- [8] McNurlin, B., and Sprague, R. "Information Systems Management in Practice." (5<sup>th</sup> ed.), Prentice Hall, (2002).
- [9] Miller, A. "Strategic Management." (3<sup>rd</sup> ed.), McGraw Hill, (1998).
- [10] Porter, M. "Strategy and the Internet." Harvard Business Review, vol.79, no.3, (March, 2002), pp.63-78.
- [11] Ward, J., and Griffiths, P. "Strategic Planning for Information Systems." (2<sup>nd</sup> ed.), John Wiley and Sons, (2002).

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# Value Creation in E-Business: The Case Study of Trend Micro

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## Abstract

In this paper, we examine the impact of actor-network field on value creation by integrating the concepts of actor-network and organizational field. In electronic business and commerce, researchers have emphasized the various sources of value creation, yet little attention has been paid to examine the issue from a cognitive or “field” perspective. Using Trend Micro as a case study, the paper demonstrates how a firm can construct a field in the community of Internet to create value and profits. Our approach and analysis are dynamic, rather than static. We show how Trend Micro is able to drive its associated actors, customers and business members to develop an evolutionary, dynamic actor-network field that serves to decrease uncertainty and increase trust. This, in turn, creates a lock-in effect and thus leads to enormous value creation.

Keywords: Actor-network Field, Trend Micro, E-Business, Case Study

## 1. Introduction

The rise of the Internet creates many advantages for e-business, particularly in increasing value [1] between transaction parties. The study, based on institutional theory [9,29], explains how organizations use the Internet to construct an effective institution or field to create value. According to Williamson [35] and Coase [7], this paper regards the source of value creation as efficiency increase and uncertainty decrease. We also observe the value creation is not a static process but a dynamic evolution.

Although some of the new institutionalism theorists argued the focus of institutional theory is on stability [e.g., 13,15,32] the alternative school of institutional theory stresses on the importance of institutional change [e.g., 3,5,8,26]. Especially, as Greenwood, Suddaby, and Hinings [14: 58] noted, most of the previous studies of field emphasized much less on field dynamics to understand “how and why institutionalized practices within a field atrophy or change.” Lawrence, Winn, and Jennings [21] further proposed adding the temporal characteristic is necessary for investigations of the

dynamics of institutionalization. In the case of Trend Micro, the institutionalized process at a field level is a dynamic process. Particularly, the rise of information technology such as the Internet per se means a dramatic change; it has substantial implication for organizational network forms [28]. Based on the approaches of institutional dynamic, we thus consider the institutional theory is applicable to exploring the effect of field change on value creation.

According to the revenue of Trend Micro from 1991 to 1999 (see Figure 1), we find an interesting phenomenon. That is, the growth of revenue is practically slow before 1995; however, the growth of revenue is soaring after 1995. The dramatic change is due to the rise of the Internet, which forms the division of two entirely different actor-network fields of Trend Micro: off-line actor-network field before and on-line actor-network field after the emergence of the Internet. The on-line actor-network field, providing an efficient and integrated on-line anti-virus service, accelerates the great growth of revenue. This leads us to understanding how Trend Micro uses an on-line actor-network field to create value.

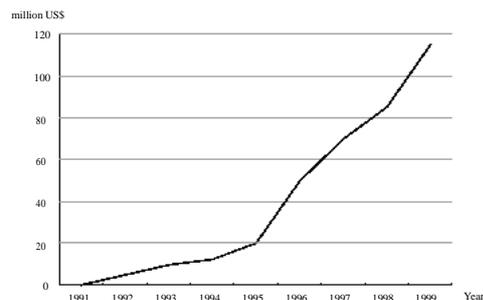


Figure 1. Revenues of Trend Micro from 1991 to 1999

(Data source: @Trend, 1999)

In this paper, we first propose an important construct of actor-network field and hold that the evolution of actor-network field is a dynamic process. Second, this study argues that organizations could effectively use the Internet to construct an on-line actor-network field, which manages and provides a collective recognized interactive model, to reduce environmental uncertainty, increase efficiency, and finally create value between actors. These arguments are shown in Figure 2. An on-line

actor-network field, based on the concepts of both organizational field and actor-network, enables actors of the field to follow the new rules, belief, and technical systems to create the shared values. Furthermore, we use a single case study of Trend Micro to clarify these arguments and to explain how the organization uses the Internet to construct an on-line actor-network field and to create value.

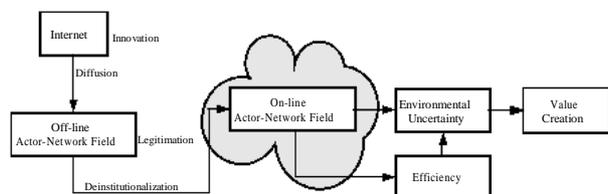


Figure 2. Conceptual model of the value creation

The paper is organized into three sections. First, we discuss the institutionalized process and the construct of actor-network field; also, we explore the relationship between on-line actor-network field and value creation. Second, the method and data of this study are introduced. Next, we analyze the value creation by Trend Micro. Finally, we summarize the results and contributions, and propose implications for firm strategies.

## 2. Theoretical Background

Lawrence, Winn, and Jennings [21] indicate “the process of institutionalization: objects are first recognized, then accepted by relatively few actors, and then widely diffused and broadly accepted within a field,” and finally reach to saturation and complete legitimacy [38]. During the institutionalized process, the concept of diffusion is viewed as a process in which an initial idea is transmitted in a social world [19], and consists the notion of searching legitimation of organizations [3]. Lawrence, Winn, and Jennings [21] hence suggested that institutionalization begin at the emergence of the new innovation such as new practices, rules, or technologies, and end prior to deinstitutionalization. The process of institutionalization, that is, an innovation at birth, is diffused, and then remains diffuseness throughout the field, and finally establishes legitimation.

For the discussion of field, we focused on a new term of field, namely, an actor-network field, based on the two constructs of “actor-network” [6,18,20] and “organizational field” [9]. Organizational field is defined by DiMaggio and Powell [9: 148] as “organizations that, in the aggregate, constitute a recognized area of institutional life: key suppliers, resources and product customers, regulatory agencies, and other organizations that provide similar services or products.” In other words, organizational field, a large and dynamic network, concerns the relationships between members and then

shapes an institution that affects the members of the field [3]. The concept of organizational field is also defined as “a set of equivalent firms that all produce the same product or service” [1]. Boons and Strannegård [3] suggested that the actors, in an organizational field, adapt to and contribute to the pressures and values of the field, and thus help materialize the characteristics of the organizational field. The organizational actors constituted an organizational field around a central issue and they had more interaction than the organizations outside the field [29,15]. The choices of organizational action, therefore, are not only determined by internal arrangements of organizations but also determined by the legitimate options defined by the actors in a field [29]. Greenwood and Hinings [13], additionally, stated that the organizational field is considered as with a taken-for-granted quality, which enables organizational actors to unconsciously accept the prevailing template as an appropriate, right, and proper way of doing things.

However, the organizational field concept is insufficiently attuned to all the possible actors’ relationships within a field. As [11] proposed the critique: institutional analysis disregards individual actors. DiMaggio and Powell [10] also recognized the institutional theory neglects the analysis of adding individual actors. The members of an organizational field are often organizations, but the actors of field are, rigidly defined, not only organizations but also, probably, individual actors. Because the “resources and product customers” [9] within a field is not solely the participating business customers; the individual actors might be also the significant ones in the field.

In contrast, “actor-network field” concept, combining the two constructs of “actor-network” [6,18] and “organizational field” [9], explicitly highlights the analysis of the institution constructed by relations of all possible actors in a field. The actor-network concept, as proposed by Latour [18] and Callon [6], concerned about “how actors, human as well as nonhuman, become “convinced” that a technology, artifact, text, image, and so on, is real” [3]. This concept stresses that a stable actor-network is established from the interrelations of the actors’ common activities. As Latour [18] pointed out, the survival of an action network implies that it provides the actors’ identity and the network stability, in turn, accepted by actors. Boons and Strannegård [3] also argued that the goal of the network constructed by actors is for network stability. Nevertheless, the term, “actor-network,” would lack the implication of organizational field. As Scott [32] noted, the “network” would be depicted as the flows or linkages shaped by participants. In contrast, the field, a common channel of discussion and dialogue for actors [15], is an arena of institutional life [9].

This paper thus integrates the concepts of organizational field and of actor-network into the “actor-network field,” and concerns the institutional interaction network of all possible actors in a field, including organizations and individual actors. Furthermore, we define the “actor-network field” as the institutionalized life area [9], providing a common channel of discussion and dialogue [15] where actors, organizations or individual actors [6,20], in a dynamic network linkages [3,21], experience the shared values and pressures collectively [3,14], and then the established field also affects the actors of the field.

While a company uses the Internet to provide an effective and dependable service structure in actor-network field, the field will be formed an on-line actor-network field. The on-line actor-network field can be viewed as a reliable interactive institution for actors to lower environmental uncertainty. As North [25] noted, in an economic exchange environment, institutions are dependable and efficient frameworks so that institutions could contribute to uncertainty reductions. Furthermore, the on-line actor-network field also has the efficient property conducting to environmental uncertainty decrease and value creation.

### 3. Method and Data

#### 3.1 Research Strategy and Sample

In this study, we choose Trend Micro as a single case study to explore the unique phenomenon of value creation, which is through on-line actor-network field. Based on the two reasons as follows, this study draws on Trend Micro as a single case study. First, for anti-virus service firms, especially anti-virus e-business firms, Trend Micro can be a business with considerable competitive advantages over the globe. Second, the Internet swept over Trend Micro in 1995, which displayed an interesting point of dramatic change of value creation in Trend Micro. These subtle phenomena lead us to explore the real cause of the remarkable achievement.

#### 3.2 Data Collection

Data collection, data analysis, and conceptualization are hard to be divided in the process of investigation, so we also adopt the principle of iterative of Glaser and Strauss [12] in the process of data collection. The closure point of data collection in this paper is when theoretical saturation [12] is reached.

Besides, to increase the construct validity of this paper, according to the principle of data collection as Yin [37] suggested, we use multiple sources of evidence. First, we collect the secondary data through Trend Micro’s webs and current press information to preliminarily gather the

historical events in Trend Micro. Second, because of the incomplete information in the first stage, we use focused interviews [24] and e-mails to fill the gap of historical events in Trend Micro to collect the first data. Five staff of Trend Micro, whose positions are marketing managers, sales manager, product manager, and the producer of web site of Trend Micro, respectively, are interviewed. Besides, we also receive and review the manuals of products and partners of Trend Micro with the assistance of these interviewees. These data are helpful to reconstruct all the evidence. The means we use is founded on the method of “triangulation” proposed by Patton [27] to develop the convergence of multiple sources of evidence and heighten construct validity [37].

Moreover, to increase the reliability of the information in the case study, this study establishes “a chain of evidence” [37] to illustrate the exploring process of a question, evidence, and results. This outcome of the exploring process is respectively pictured in Figure 1, Figure 3, and Figure 4.

#### 3.3 Data Analysis

In data analysis, this paper uses the two analytical techniques of “time-series” and “pattern-matching” [37]. In the first stage of analysis, we use the analytical technique of chronologies, a special form of time-series analysis. Yin [37] proposed allocating events in a chronology can make researchers clearly understand the causal relationship of events in a specific period.

In the second stage of analysis, the technique of “pattern-matching” is employed. This technique compares the consistence between an empirical pattern and the pattern of theoretical proposition. Yin [37] further argued if the two patterns coincide, it can reinforce internal validity.

In next section we discuss the evolution of Trend Micro in a longitudinal approach. Also, the detailed discovery showing the causal relationship between on-line actor-network field and value creation is illustrated in the following sections.

### 4. The Analysis of Value Creation by Trend Micro

This paper collects and chronicles the historic events in Trend Micro, as shown in Table 1. We employ a longitudinal approach to analyze the historic events in Trend Micro by dividing them into four stages: (1) the stage of foundations: 1988-1989; (2) the stage of independent anti-virus product development: 1990-1994; (3) the stage of expanding Internet anti-virus service: 1995-1998; and (4) the stage of integrated Internet service: 1999-2002. We further analyze and illustrate the

four periods of value creation by Trend Micro (see Figure 3).

Table 1. The chronology in Trend Micro

Year	Historic events
2001	Market HouseCall, integrated with the patent of Trojan System Cleaner.
2001	Market PC-cillin2002.
2000	Ally itself with UniSVR Corporation providing eDoctor anti-virus outsourcing service.
1999	Market “eManager” software for e-mails security management.
1999	Market “WebManager” software for webs security management.
1999	Establish five eDoctor laboratories, in America, Germany, Taiwan, Japan, and the Philippines; undertake the local eDoctor business.
1999	Unveil “eDoctor” anti-virus outsourcing service.
1998	Unveil “Trend Virus Control SystemTM.”
1997	“On The Fly” was granted American technological patent.
1996	Unveil InterScan VirusWall.
1996	Unveil the anti-virus system of “ScanMail for Exchange” for Microsoft Exchange Server.
1996	Unveil InterScan WebProtect, a group software anti-virus system.
1996	Develop the patent technology of “Macro TrapTM” to intercept and clean the unknown document macro viruses.
1996	Develop ScanMail for Lotus Notes.
1996	Market HouseCall for on-line scan virus.
1995	Unveil PC-cillin95.
1994	Unveil “Mobile Protect” system.
1994	Ally itself with Intel to market “Intel LANDesk Virus Protect” and provide the network security and anti-virus technology for Intel.
1993	Unveil StationLock, an interface card designed for anti-virus and access control.
1992	Develop “Chipaway Virus”; Intel integrated “Chipaway Virus” into the network card of Ethernet Express 16.
1991	“Server Protect,” an anti-virus core technology, was authorized to Intel and marketed to European and America by the renamed brand of ‘LANDesk Virus Protect’.
1990	Market PC-cillin.
1988	Founded in California USA; use a “rule-based” method of the monitor viruses’ behavior to detect the unknown viruses.

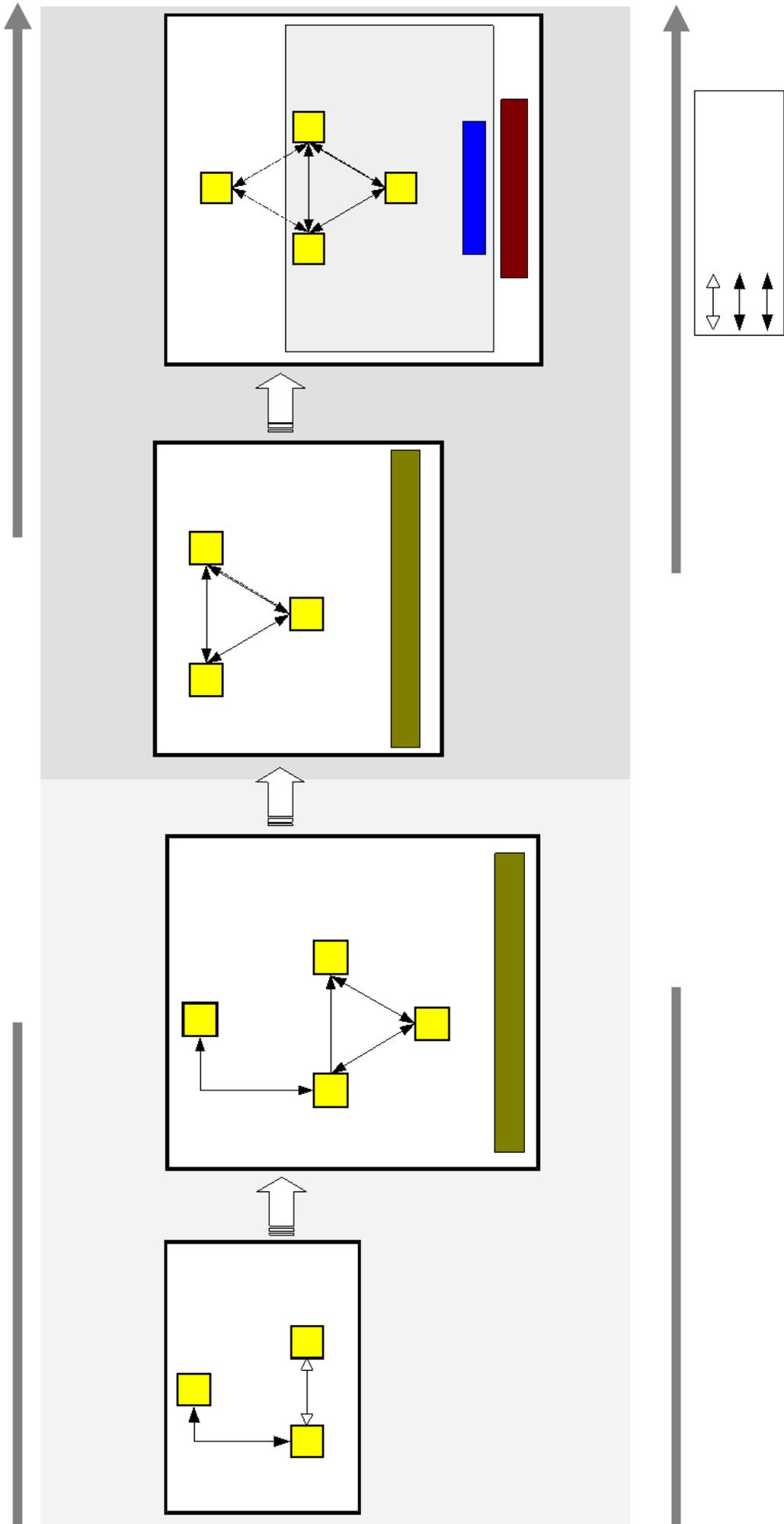
#### 4.1 The stage of foundations, 1988-1989

The actor-network field of Trend Micro in this period is shown as Stage I in Figure 3. In this period, Trend Micro did not really launch the anti-virus business. The focus of the business strategy was on allying itself with an anti-pirated software firm such as Rainbow Technologies Corporation in order to establish the business foundations. Although the boot-type virus happened to rise, it had no serious impact on businesses and end-users. The computer users, hence, were not significantly influenced by the uncertainty of virus attack. On the other hand, PC-cillin did not come to the market in this stage, though this product was successfully developed. Trend Micro with its customers, consequently, did not construct a recognized actor-network field.

#### 4.2 The stage of independent anti-virus product development, 1990-1994

The actor-network field of Trend Micro in this period is shown as Stage II in Figure 3. There are two focuses of the business strategy in this phase. First, Trend Micro allied itself with such computer hardware companies as Intel to enhance the reputation of Trend Micro in

America. Second, it established the PC-cillin agencies through the world to expand the market channels. In this period, Macro viruses happened to appear; meanwhile, Trend Micro’s anti-virus service provided the mailing service of the quarterly-updated computer virus codes. This practice was accompanied with two shortcomings. First, the uncertainty of virus attack that customers met was increasing between updating services of virus codes. Second, the cost of mail service was high between transaction parties. For service organizations, it is essential that they deliver the efficient service that could create advantages and economize associated costs [16]. However, according to the inefficient off-line actor-network field of Trend Micro and its parties, the type of field failed to effectively decrease environmental uncertainty resulting from computer viruses. The performance of value creation during this period, accordingly, was defined as a value creation of low level.



### 4.3 The stage of expanding Internet anti-virus service, 1995-1998

The actor-network field of Trend Micro in this period is shown as Stage III in Figure 3. In this period, the focus of business strategy was on Internet anti-virus service. Hence, it significantly changed the actor-network field of Trend Micro with its parties. For example, in 1995, Trend Micro developed the technique of 'One Button Update' that customers could update the computer virus codes on the Internet in real time. In 1996, Trend Micro developed a series of anti-virus products for enterprises such as OfficeScan, ScanMail for Exchange, InterScan VirusWall, and InterScan WebProtect. In 1998, Trend Micro developed Trend Virus Control System (TVCS), a centralized management platform, which enabled the information management department to setup, monitor, and manage all anti-virus softwares. The Internet anti-virus services or products lead to an efficient on-line actor-network field and regulate the behaviors of the field members in a recognized interactive institution. This kind of field, therefore, can decrease environmental uncertainty caused by viruses. As argued in [25], institutions are characterized with dependable and efficient frameworks in order that they can help reduce uncertainty. Many studies also show the evidence that the Internet could be employed to accelerate the service delivery and reduce service costs and uncertainty [e.g., 4,16,23,34]. The performance of value creation in this period, accordingly, was defined as a value creation of middle-high level.

### 4.4 The stage of integrated Internet service, 1999-2002

The actor-network field of Trend Micro in this period is shown as Stage IV in Figure 3. In this period, Trend Micro continued to provide the Internet anti-virus pattern of the last period for their end-user customers; moreover, Trend Micro provided a more integrated anti-virus Internet service. For example, PC-cillin2002 not only has the functions of the previous editions but also incorporates the function of the personal firewall. That is, end-user customers in the on-line actor-network field have access to services of efficiency and decreased uncertainty of virus attack owing to a more integrated Internet service actor-network field. For business customers, the focus business strategy of Trend Micro was on using eDoctor service to provide an integrated Internet anti-virus service. eDoctor offers the OfficeScan, ServerProtect, ScanMail, InterScan VirusWall and Trend Virus Control System with authorization. Business customers obtained eDoctor anti-virus service from

eDoctor service center, whose anti-virus technology was supported by Trend Micro. Wise and Morrison [36] showed businesses need to consider how to lower uncertainty, e.g., "Which exchanges should we participate in?" or "What software should we invest in?" Besides, due to the devotion to IT activities involving uncertainty, organizations need to decide which IT activities should stay in-house and which should outsource to the specific expert parties [22]. Lacity and Willcocks [17] suggested that selective IT sourcing be the most contribution to cost reduction among the three alternatives of total insourcing, total outsourcing, and selective sourcing. According to the implication of these authors' arguments, if a business can provide an integrated service for its customers and customers choose selective IT sourcing, it could decrease uncertainty through customers' neglect. The eDoctor and PC-cillin2002 integrated the Internet anti-virus service, thus a more institutionalized and efficient on-line actor-network field that further significantly lowered the uncertainty of virus attack. The performance of value creation during this period, accordingly, was defined as a value creation of high level.

## 5. Results and Conclusions

Based on the theoretical and empirical discussion, we illustrate the results of analysis as shown in Figure 4. Figure 4 shows the processes and results of Trend Micro using the on-line actor-network to create transaction value. The evolution process is from 1987 to 2002. In the period, the three main types of computer virus appeared, i.e. the boot-type virus, the macro virus, and the e-mail virus. In the first stage of this case, from 1988 to 1989, the boot-type viruses appeared. In the second stage, from 1990 to 1994, the macro virus emerged.

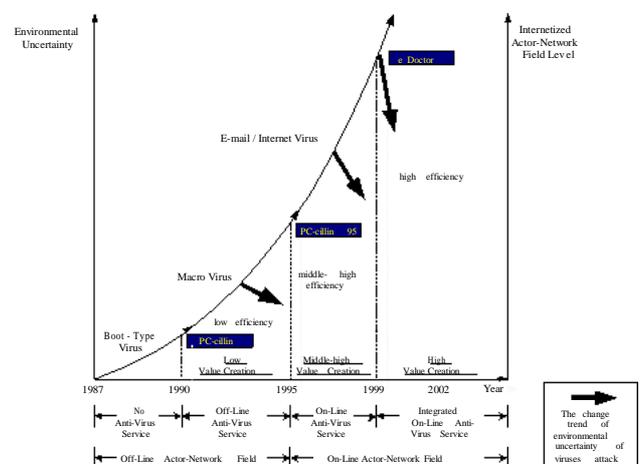


Figure 4. The curve of create value of Trend Micro

And in the third and fourth stages, from 1995 until

now, the most popular type of virus is the e-mail virus. The boundaries of these stages are just the emergence of three representative products, PC-cillin, PC-cillin 95, and eDoctor. Before 1995, prior to the PC-cillin 95 entered the market; Trend Micro with its actors of the field remained an off-line actor-network field. The anti-virus service of this period is called “off-line anti-virus service.” After 1995, the PC-cillin 95, especially eDoctor, entered the market; Trend Micro with its actors of the field transforms an on-line actor-network field. From 1995 to 1999, the anti-virus service is called “on-line anti-virus service.” Since 1999, the anti-virus service has been called “integrated on-line anti-virus service.” The evolution of actor-network field also presents three levels of efficiency, three changing trends of environmental uncertainty of virus attack, and three levels of value creation. As the Internetized level of the on-line actor-network field increases, the environmental uncertainty of virus attack is continually decreased, the efficiency is unceasingly improved, and the value creation is thus constantly increased.

In sum, we argue that, first, the higher the level of the Internetized actor-network field, the lower the uncertainty of virus attack. Second, the higher the level of the Internetized actor-network field, the higher the efficiency in the anti-virus service. Third, the higher the efficiency in the anti-virus service, the lower the uncertainty of virus attack. Fourth, the higher the level of the integrated Internet anti-virus service, the lower the uncertainty of virus attack. Finally, the lower the uncertainty of virus attack, the higher value creation.

In the longitudinal analysis of this case study, we find that because the former off-line actor-network field of Trend Micro lacks efficiency in the first two stages, the transaction value could not be significantly increased. In contrast, the on-line actor-network field in the later two stages can lower the uncertainty of virus attack and further increase value creation in that it has high efficiency.

Consequently, this paper makes two contributions. First, we propose an important and novelty construct “actor-network field,” based on a perspective of dynamic evolution. Second, according to the case of Trend Micro, the important issue arises in this paper that organizations can effectively use the Internet to construct an on-line actor-network field to facilitate the reduction in uncertainty and finally contribute to the value creation between actors.

## References

- [1] Alter, C. and Hage, J. *Organizations working together*. Newbury Park, CA: Sage, 1993.
- [2] Amit, R. and Zott, C. “Value creation in e-business,” *Strategic Management Journal*, 2001, 22, 493-520.
- [3] Boons, F. and Strannegård, L. “Organizations coping with their natural environment,” *International Studies of Management & Organization*, 2000, Fall, 30(3), 7-17.
- [4] Boudreau, M.-C., Loch, K. D., Robey, D., and Staub, D. “Going global: Using information technology to advance the competitiveness of the virtual transnational organization,” *Academy of Management Executive*, 1998, 12(4): 120-128.
- [5] Brunsson, N. and Olsen, J. P., *The reforming organization*, London: Routledge, 1993.
- [6] Callon, M. “Techno-Economic Networks and Irreversibility.” In *A sociology of monsters: Essays on power, technology, and domination*, ed. J. Law, London: Routledge, 1991, 132-161.
- [7] Coase, R. “The nature of the firm,” *Economica*, 1937, 4: 386-405. Reprinted in: Coase, R., 1988, *The firm, the market and the law*, Chicago: University of Chicago Press.
- [8] Czarniawska, B. and Sevón, G. *Translating organizational change*, eds. 1996. Berlin: de Gruyter.
- [9] DiMaggio, P. J. and Powell, W. W. “The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields,” *American Sociological Review*, 1983, 48: 147-160.
- [10] DiMaggio, P. J. and Powell, W. W. *The new institutionalism in organizational analysis*, Chicago: University of Chicago Press, 1991.
- [11] Giddens, A. *The constitution of society: Outline of the theory of structuration*, Berkeley: University of California Press, 1984.
- [12] Glaser, B. G. and Strauss, A. L. *The discovery of grounded theory*, Chicago, IL: Aldine, 1967.
- [13] Greenwood, R. and Hinings, C. R. “Understanding radical organizational change: Bringing together the old and the new institutionalism,” *Academy of Management Review*, 1996, 21(4), 1022-1054.
- [14] Greenwood, R. Suddaby, R., and Hinings, C. R., “Theorizing change: The role of professional associations in the transformation of institutionalized fields,” *Academy of Management Journal*, 2002, 45(1), 58-80.
- [15] Hoffman, A. J. 1999. “Institutional evolution and change: Environmentalism and the U.S. chemical industry,” *Academy of Management Journal*, 42(4), 351-371.
- [16] Kelley, S. W. “Efficiency in service delivery: Technological or humanistic approaches?” *The Journal of Service Marketing*, 1989, summer, 3(3), 43-50.
- [17] Lacity, M. and Willcocks, L. *Best practices in information technology sourcing*, Oxford Executive Research Briefings, 1996, Oxford, England.
- [18] Latour, B. “The power of associations,” in *Power*,

- action and belief. A new sociology of knowledge? J. Law, (ed.), 261-277, London: Routledge and Kegan Paul, 1986.
- [19] Latour, B. *Aramis or the love of technology*. Cambridge: Harvard University Press, 1996.
- [20] Latour, B. *Science in action: How to follow scientists and engineers through society*, Cambridge: Harvard University Press, 1987.
- [21] Lawrence, T. B., Winn, M. I., and Jennings, P. D. "The temporal dynamics of institutionalization," *Academy of Management Review*, 2001, 26(4), 624-644.
- [22] Lonsdale, C. "Lock-in to supplier dominance: On the dangers of asset specificity for the outsourcing decision," *Journal of Supply Chain Management*, 2001, Spring, 22-27.
- [23] Matthyssens, P. and Vandenbempt, K. "Creating competitive advantage in industrial services," *Journal of Business & Industrial Marketing*, 1998, 13(4/5), 339-355.
- [24] Merton, R. K., Fiske, M., and Kendall, P. L. *The focused interview: A manual of problems and procedures*, 2<sup>d</sup> ed., New York: Free Press, 1990.
- [25] North, D. C. *Institutions, institutional change and economic performance*, Cambridge University Press, 1990.
- [26] Ouchi, W. G. "Markets, bureaucracies, and clans." *Administrative Science Quarterly*, 1980, 25, 129-141.
- [27] Patton, M. Q. *How to use qualitative methods in evaluation*, Newbury Park, CA: Sage, 1987.
- [28] Powell, W. W. "Neither market nor hierarchy: Network forms of organization," In B. W. Staw and L. L. Cummings (eds.), *Research in Organizational Behavior*, 12, 295-336. Greenwich, CT: JAI Press, 1990.
- [29] Scott, W. R. "The evolution of organization theory," In *Studies in organizational sociology: Essays in honor of Charles K. Warriner*, edited by Gale Miller. Greenwich, CT: JAI, 1991, 53-68.
- [30] Scott, W. R. "The organization of environments: Network, cultural, and historical elements," In *Organizational environments: Ritual and rationality*, Meyer, J. W. and Scott, W. R. Updated Edition, Beverly Hills, CA: Sage, 1992, 155-175.
- [31] Scott, W. R. *Institutions and organizations*, London, CA: Sage, 1995.
- [32] Tolbert, P. S. "Resource dependence and institutional environments: Sources of administrative structure in institutions of higher education," *Administrative Science Quarterly*, 1985, 30: 1-13.
- [33] Tolbert, P. S., and Zucker, L. G. "Institutional sources of change in the formal structure of organizations: The diffusion of civil service reform, 1880-1935," *Administrative Science Quarterly*, 1983, 28, 22-39.
- [34] Watson, R. T., Akselsen, S., and Pitt, L. F. "Attractors: Building mountains in the flat landscape of the world wide web," *California Management Review*, 1998, Winter, 40(2), 36-56.
- [35] Williamson, O. E. *The economic institutions of capitalism*, 1985, New York: The Free Press.
- [36] Wise, R. and Morrison, D. "Beyond the exchange: The future of B2B," *Harvard Business Review*, 2000, November-December, 86-96.
- [37] Yin, R. K. *Case study research: Design and methods*, 2nd Ed., London, CA: Sage, 1994.
- [38] Zucker, L. G. "Institutional theories of organizations," *Annual Review of Sociology*, 13, 443-464, 1987.

# Value Creation in E-Business: The Case Study of Trend Micro

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## Abstract

In this paper, we examine the impact of actor-network field on value creation by integrating the concepts of actor-network and organizational field. In electronic business and commerce, researchers have emphasized the various sources of value creation, yet little attention has been paid to examine the issue from a cognitive or “field” perspective. Using Trend Micro as a case study, the paper demonstrates how a firm can construct a field in the community of Internet to create value and profits. Our approach and analysis are dynamic, rather than static. We show how Trend Micro is able to drive its associated actors, customers and business members to develop an evolutionary, dynamic actor-network field that serves to decrease uncertainty and increase trust. This, in turn, creates a lock-in effect and thus leads to enormous value creation.

Keywords: Actor-network Field, Trend Micro, E-Business, Case Study

## 1. Introduction

The rise of the Internet creates many advantages for e-business, particularly in increasing value [1] between transaction parties. The study, based on institutional theory [9,29], explains how organizations use the Internet to construct an effective institution or field to create value. According to Williamson [35] and Coase [7], this paper regards the source of value creation as efficiency increase and uncertainty decrease. We also observe the value creation is not a static process but a dynamic evolution.

Although some of the new institutionalism theorists argued the focus of institutional theory is on stability [e.g., 13,15,32] the alternative school of institutional theory stresses on the importance of institutional change [e.g., 3,5,8,26]. Especially, as Greenwood, Suddaby, and Hinings [14: 58] noted, most of the previous studies of field emphasized much less on field dynamics to understand “how and why institutionalized practices within a field atrophy or change.” Lawrence, Winn, and Jennings [21] further proposed adding the temporal characteristic is necessary for investigations of the

dynamics of institutionalization. In the case of Trend Micro, the institutionalized process at a field level is a dynamic process. Particularly, the rise of information technology such as the Internet per se means a dramatic change; it has substantial implication for organizational network forms [28]. Based on the approaches of institutional dynamic, we thus consider the institutional theory is applicable to exploring the effect of field change on value creation.

According to the revenue of Trend Micro from 1991 to 1999 (see Figure 1), we find an interesting phenomenon. That is, the growth of revenue is practically slow before 1995; however, the growth of revenue is soaring after 1995. The dramatic change is due to the rise of the Internet, which forms the division of two entirely different actor-network fields of Trend Micro: off-line actor-network field before and on-line actor-network field after the emergence of the Internet. The on-line actor-network field, providing an efficient and integrated on-line anti-virus service, accelerates the great growth of revenue. This leads us to understanding how Trend Micro uses an on-line actor-network field to create value.

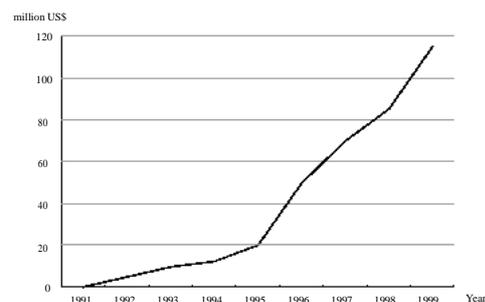


Figure 1. Revenues of Trend Micro from 1991 to 1999

(Data source: @Trend, 1999)

In this paper, we first propose an important construct of actor-network field and hold that the evolution of actor-network field is a dynamic process. Second, this study argues that organizations could effectively use the Internet to construct an on-line actor-network field, which manages and provides a collective recognized interactive model, to reduce environmental uncertainty, increase efficiency, and finally create value between actors. These arguments are shown in Figure 2. An on-line

actor-network field, based on the concepts of both organizational field and actor-network, enables actors of the field to follow the new rules, belief, and technical systems to create the shared values. Furthermore, we use a single case study of Trend Micro to clarify these arguments and to explain how the organization uses the Internet to construct an on-line actor-network field and to create value.

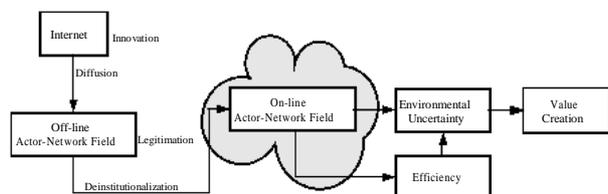


Figure 2. Conceptual model of the value creation

The paper is organized into three sections. First, we discuss the institutionalized process and the construct of actor-network field; also, we explore the relationship between on-line actor-network field and value creation. Second, the method and data of this study are introduced. Next, we analyze the value creation by Trend Micro. Finally, we summarize the results and contributions, and propose implications for firm strategies.

## 2. Theoretical Background

Lawrence, Winn, and Jennings [21] indicate “the process of institutionalization: objects are first recognized, then accepted by relatively few actors, and then widely diffused and broadly accepted within a field,” and finally reach to saturation and complete legitimacy [38]. During the institutionalized process, the concept of diffusion is viewed as a process in which an initial idea is transmitted in a social world [19], and consists the notion of searching legitimation of organizations [3]. Lawrence, Winn, and Jennings [21] hence suggested that institutionalization begin at the emergence of the new innovation such as new practices, rules, or technologies, and end prior to deinstitutionalization. The process of institutionalization, that is, an innovation at birth, is diffused, and then remains diffuseness throughout the field, and finally establishes legitimation.

For the discussion of field, we focused on a new term of field, namely, an actor-network field, based on the two constructs of “actor-network” [6,18,20] and “organizational field” [9]. Organizational field is defined by DiMaggio and Powell [9: 148] as “organizations that, in the aggregate, constitute a recognized area of institutional life: key suppliers, resources and product customers, regulatory agencies, and other organizations that provide similar services or products.” In other words, organizational field, a large and dynamic network, concerns the relationships between members and then

shapes an institution that affects the members of the field [3]. The concept of organizational field is also defined as “a set of equivalent firms that all produce the same product or service” [1]. Boons and Strannegård [3] suggested that the actors, in an organizational field, adapt to and contribute to the pressures and values of the field, and thus help materialize the characteristics of the organizational field. The organizational actors constituted an organizational field around a central issue and they had more interaction than the organizations outside the field [29,15]. The choices of organizational action, therefore, are not only determined by internal arrangements of organizations but also determined by the legitimate options defined by the actors in a field [29]. Greenwood and Hinings [13], additionally, stated that the organizational field is considered as with a taken-for-granted quality, which enables organizational actors to unconsciously accept the prevailing template as an appropriate, right, and proper way of doing things.

However, the organizational field concept is insufficiently attuned to all the possible actors’ relationships within a field. As [11] proposed the critique: institutional analysis disregards individual actors. DiMaggio and Powell [10] also recognized the institutional theory neglects the analysis of adding individual actors. The members of an organizational field are often organizations, but the actors of field are, rigidly defined, not only organizations but also, probably, individual actors. Because the “resources and product customers” [9] within a field is not solely the participating business customers; the individual actors might be also the significant ones in the field.

In contrast, “actor-network field” concept, combining the two constructs of “actor-network” [6,18] and “organizational field” [9], explicitly highlights the analysis of the institution constructed by relations of all possible actors in a field. The actor-network concept, as proposed by Latour [18] and Callon [6], concerned about “how actors, human as well as nonhuman, become “convinced” that a technology, artifact, text, image, and so on, is real” [3]. This concept stresses that a stable actor-network is established from the interrelations of the actors’ common activities. As Latour [18] pointed out, the survival of an action network implies that it provides the actors’ identity and the network stability, in turn, accepted by actors. Boons and Strannegård [3] also argued that the goal of the network constructed by actors is for network stability. Nevertheless, the term, “actor-network,” would lack the implication of organizational field. As Scott [32] noted, the “network” would be depicted as the flows or linkages shaped by participants. In contrast, the field, a common channel of discussion and dialogue for actors [15], is an arena of institutional life [9].

This paper thus integrates the concepts of organizational field and of actor-network into the “actor-network field,” and concerns the institutional interaction network of all possible actors in a field, including organizations and individual actors. Furthermore, we define the “actor-network field” as the institutionalized life area [9], providing a common channel of discussion and dialogue [15] where actors, organizations or individual actors [6,20], in a dynamic network linkages [3,21], experience the shared values and pressures collectively [3,14], and then the established field also affects the actors of the field.

While a company uses the Internet to provide an effective and dependable service structure in actor-network field, the field will be formed an on-line actor-network field. The on-line actor-network field can be viewed as a reliable interactive institution for actors to lower environmental uncertainty. As North [25] noted, in an economic exchange environment, institutions are dependable and efficient frameworks so that institutions could contribute to uncertainty reductions. Furthermore, the on-line actor-network field also has the efficient property conducting to environmental uncertainty decrease and value creation.

### 3. Method and Data

#### 3.1 Research Strategy and Sample

In this study, we choose Trend Micro as a single case study to explore the unique phenomenon of value creation, which is through on-line actor-network field. Based on the two reasons as follows, this study draws on Trend Micro as a single case study. First, for anti-virus service firms, especially anti-virus e-business firms, Trend Micro can be a business with considerable competitive advantages over the globe. Second, the Internet swept over Trend Micro in 1995, which displayed an interesting point of dramatic change of value creation in Trend Micro. These subtle phenomena lead us to explore the real cause of the remarkable achievement.

#### 3.2 Data Collection

Data collection, data analysis, and conceptualization are hard to be divided in the process of investigation, so we also adopt the principle of iterative of Glaser and Strauss [12] in the process of data collection. The closure point of data collection in this paper is when theoretical saturation [12] is reached.

Besides, to increase the construct validity of this paper, according to the principle of data collection as Yin [37] suggested, we use multiple sources of evidence. First, we collect the secondary data through Trend Micro’s webs and current press information to preliminarily gather the

historical events in Trend Micro. Second, because of the incomplete information in the first stage, we use focused interviews [24] and e-mails to fill the gap of historical events in Trend Micro to collect the first data. Five staff of Trend Micro, whose positions are marketing managers, sales manager, product manager, and the producer of web site of Trend Micro, respectively, are interviewed. Besides, we also receive and review the manuals of products and partners of Trend Micro with the assistance of these interviewees. These data are helpful to reconstruct all the evidence. The means we use is founded on the method of “triangulation” proposed by Patton [27] to develop the convergence of multiple sources of evidence and heighten construct validity [37].

Moreover, to increase the reliability of the information in the case study, this study establishes “a chain of evidence” [37] to illustrate the exploring process of a question, evidence, and results. This outcome of the exploring process is respectively pictured in Figure 1, Figure 3, and Figure 4.

#### 3.3 Data Analysis

In data analysis, this paper uses the two analytical techniques of “time-series” and “pattern-matching” [37]. In the first stage of analysis, we use the analytical technique of chronologies, a special form of time-series analysis. Yin [37] proposed allocating events in a chronology can make researchers clearly understand the causal relationship of events in a specific period.

In the second stage of analysis, the technique of “pattern-matching” is employed. This technique compares the consistence between an empirical pattern and the pattern of theoretical proposition. Yin [37] further argued if the two patterns coincide, it can reinforce internal validity.

In next section we discuss the evolution of Trend Micro in a longitudinal approach. Also, the detailed discovery showing the causal relationship between on-line actor-network field and value creation is illustrated in the following sections.

### 4. The Analysis of Value Creation by Trend Micro

This paper collects and chronicles the historic events in Trend Micro, as shown in Table 1. We employ a longitudinal approach to analyze the historic events in Trend Micro by dividing them into four stages: (1) the stage of foundations: 1988-1989; (2) the stage of independent anti-virus product development: 1990-1994; (3) the stage of expanding Internet anti-virus service: 1995-1998; and (4) the stage of integrated Internet service: 1999-2002. We further analyze and illustrate the

four periods of value creation by Trend Micro (see Figure 3).

Table 1. The chronology in Trend Micro

Year	Historic events
2001	Market HouseCall, integrated with the patent of Trojan System Cleaner.
2001	Market PC-cillin2002.
2000	Ally itself with UniSVR Corporation providing eDoctor anti-virus outsourcing service.
1999	Market “eManager” software for e-mails security management.
1999	Market “WebManager” software for webs security management.
1999	Establish five eDoctor laboratories, in America, Germany, Taiwan, Japan, and the Philippines; undertake the local eDoctor business.
1999	Unveil “eDoctor” anti-virus outsourcing service.
1998	Unveil “Trend Virus Control SystemTM.”
1997	“On The Fly” was granted American technological patent.
1996	Unveil InterScan VirusWall.
1996	Unveil the anti-virus system of “ScanMail for Exchange” for Microsoft Exchange Server.
1996	Unveil InterScan WebProtect, a group software anti-virus system.
1996	Develop the patent technology of “Macro TrapTM” to intercept and clean the unknown document macro viruses.
1996	Develop ScanMail for Lotus Notes.
1996	Market HouseCall for on-line scan virus.
1995	Unveil PC-cillin95.
1994	Unveil “Mobile Protect” system.
1994	Ally itself with Intel to market “Intel LANDesk Virus Protect” and provide the network security and anti-virus technology for Intel.
1993	Unveil StationLock, an interface card designed for anti-virus and access control.
1992	Develop “Chipaway Virus”; Intel integrated “Chipaway Virus” into the network card of Ethernet Express 16.
1991	“Server Protect,” an anti-virus core technology, was authorized to Intel and marketed to European and America by the renamed brand of ‘LANDesk Virus Protect’.
1990	Market PC-cillin.
1988	Founded in California USA; use a “rule-based” method of the monitor viruses’ behavior to detect the unknown viruses.

#### 4.1 The stage of foundations, 1988-1989

The actor-network field of Trend Micro in this period is shown as Stage I in Figure 3. In this period, Trend Micro did not really launch the anti-virus business. The focus of the business strategy was on allying itself with an anti-pirated software firm such as Rainbow Technologies Corporation in order to establish the business foundations. Although the boot-type virus happened to rise, it had no serious impact on businesses and end-users. The computer users, hence, were not significantly influenced by the uncertainty of virus attack. On the other hand, PC-cillin did not come to the market in this stage, though this product was successfully developed. Trend Micro with its customers, consequently, did not construct a recognized actor-network field.

#### 4.2 The stage of independent anti-virus product development, 1990-1994

The actor-network field of Trend Micro in this period is shown as Stage II in Figure 3. There are two focuses of the business strategy in this phase. First, Trend Micro allied itself with such computer hardware companies as Intel to enhance the reputation of Trend Micro in

America. Second, it established the PC-cillin agencies through the world to expand the market channels. In this period, Macro viruses happened to appear; meanwhile, Trend Micro’s anti-virus service provided the mailing service of the quarterly-updated computer virus codes. This practice was accompanied with two shortcomings. First, the uncertainty of virus attack that customers met was increasing between updating services of virus codes. Second, the cost of mail service was high between transaction parties. For service organizations, it is essential that they deliver the efficient service that could create advantages and economize associated costs [16]. However, according to the inefficient off-line actor-network field of Trend Micro and its parties, the type of field failed to effectively decrease environmental uncertainty resulting from computer viruses. The performance of value creation during this period, accordingly, was defined as a value creation of low level.



### 4.3 The stage of expanding Internet anti-virus service, 1995-1998

The actor-network field of Trend Micro in this period is shown as Stage III in Figure 3. In this period, the focus of business strategy was on Internet anti-virus service. Hence, it significantly changed the actor-network field of Trend Micro with its parties. For example, in 1995, Trend Micro developed the technique of 'One Button Update' that customers could update the computer virus codes on the Internet in real time. In 1996, Trend Micro developed a series of anti-virus products for enterprises such as OfficeScan, ScanMail for Exchange, InterScan VirusWall, and InterScan WebProtect. In 1998, Trend Micro developed Trend Virus Control System (TVCS), a centralized management platform, which enabled the information management department to setup, monitor, and manage all anti-virus softwares. The Internet anti-virus services or products lead to an efficient on-line actor-network field and regulate the behaviors of the field members in a recognized interactive institution. This kind of field, therefore, can decrease environmental uncertainty caused by viruses. As argued in [25], institutions are characterized with dependable and efficient frameworks in order that they can help reduce uncertainty. Many studies also show the evidence that the Internet could be employed to accelerate the service delivery and reduce service costs and uncertainty [e.g., 4,16,23,34]. The performance of value creation in this period, accordingly, was defined as a value creation of middle-high level.

### 4.4 The stage of integrated Internet service, 1999-2002

The actor-network field of Trend Micro in this period is shown as Stage IV in Figure 3. In this period, Trend Micro continued to provide the Internet anti-virus pattern of the last period for their end-user customers; moreover, Trend Micro provided a more integrated anti-virus Internet service. For example, PC-cillin2002 not only has the functions of the previous editions but also incorporates the function of the personal firewall. That is, end-user customers in the on-line actor-network field have access to services of efficiency and decreased uncertainty of virus attack owing to a more integrated Internet service actor-network field. For business customers, the focus business strategy of Trend Micro was on using eDoctor service to provide an integrated Internet anti-virus service. eDoctor offers the OfficeScan, ServerProtect, ScanMail, InterScan VirusWall and Trend Virus Control System with authorization. Business customers obtained eDoctor anti-virus service from

eDoctor service center, whose anti-virus technology was supported by Trend Micro. Wise and Morrison [36] showed businesses need to consider how to lower uncertainty, e.g., "Which exchanges should we participate in?" or "What software should we invest in?" Besides, due to the devotion to IT activities involving uncertainty, organizations need to decide which IT activities should stay in-house and which should outsource to the specific expert parties [22]. Lacity and Willcocks [17] suggested that selective IT sourcing be the most contribution to cost reduction among the three alternatives of total insourcing, total outsourcing, and selective sourcing. According to the implication of these authors' arguments, if a business can provide an integrated service for its customers and customers choose selective IT sourcing, it could decrease uncertainty through customers' neglect. The eDoctor and PC-cillin2002 integrated the Internet anti-virus service, thus a more institutionalized and efficient on-line actor-network field that further significantly lowered the uncertainty of virus attack. The performance of value creation during this period, accordingly, was defined as a value creation of high level.

## 5. Results and Conclusions

Based on the theoretical and empirical discussion, we illustrate the results of analysis as shown in Figure 4. Figure 4 shows the processes and results of Trend Micro using the on-line actor-network to create transaction value. The evolution process is from 1987 to 2002. In the period, the three main types of computer virus appeared, i.e. the boot-type virus, the macro virus, and the e-mail virus. In the first stage of this case, from 1988 to 1989, the boot-type viruses appeared. In the second stage, from 1990 to 1994, the macro virus emerged.

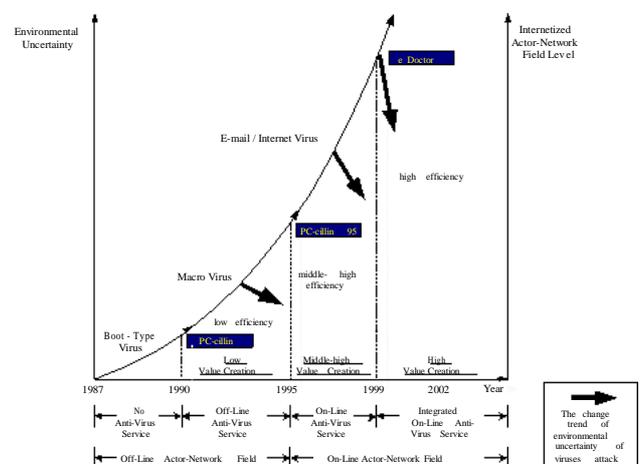


Figure 4. The curve of create value of Trend Micro

And in the third and fourth stages, from 1995 until

now, the most popular type of virus is the e-mail virus. The boundaries of these stages are just the emergence of three representative products, PC-cillin, PC-cillin 95, and eDoctor. Before 1995, prior to the PC-cillin 95 entered the market; Trend Micro with its actors of the field remained an off-line actor-network field. The anti-virus service of this period is called “off-line anti-virus service.” After 1995, the PC-cillin 95, especially eDoctor, entered the market; Trend Micro with its actors of the field transforms an on-line actor-network field. From 1995 to 1999, the anti-virus service is called “on-line anti-virus service.” Since 1999, the anti-virus service has been called “integrated on-line anti-virus service.” The evolution of actor-network field also presents three levels of efficiency, three changing trends of environmental uncertainty of virus attack, and three levels of value creation. As the Internetized level of the on-line actor-network field increases, the environmental uncertainty of virus attack is continually decreased, the efficiency is unceasingly improved, and the value creation is thus constantly increased.

In sum, we argue that, first, the higher the level of the Internetized actor-network field, the lower the uncertainty of virus attack. Second, the higher the level of the Internetized actor-network field, the higher the efficiency in the anti-virus service. Third, the higher the efficiency in the anti-virus service, the lower the uncertainty of virus attack. Fourth, the higher the level of the integrated Internet anti-virus service, the lower the uncertainty of virus attack. Finally, the lower the uncertainty of virus attack, the higher value creation.

In the longitudinal analysis of this case study, we find that because the former off-line actor-network field of Trend Micro lacks efficiency in the first two stages, the transaction value could not be significantly increased. In contrast, the on-line actor-network field in the later two stages can lower the uncertainty of virus attack and further increase value creation in that it has high efficiency.

Consequently, this paper makes two contributions. First, we propose an important and novelty construct “actor-network field,” based on a perspective of dynamic evolution. Second, according to the case of Trend Micro, the important issue arises in this paper that organizations can effectively use the Internet to construct an on-line actor-network field to facilitate the reduction in uncertainty and finally contribute to the value creation between actors.

## References

[1] Alter, C. and Hage, J. *Organizations working together*. Newbury Park, CA: Sage, 1993.  
 [2] Amit, R. and Zott, C. “Value creation in e-business,”

*Strategic Management Journal*, 2001, 22, 493-520.  
 [3] Boons, F. and Strannegård, L. “Organizations coping with their natural environment,” *International Studies of Management & Organization*, 2000, Fall, 30(3), 7-17.  
 [4] Boudreau, M.-C., Loch, K. D., Robey, D., and Staub, D. “Going global: Using information technology to advance the competitiveness of the virtual transnational organization,” *Academy of Management Executive*, 1998, 12(4): 120-128.  
 [5] Brunsson, N. and Olsen, J. P., *The reforming organization*, London: Routledge, 1993.  
 [6] Callon, M. “Techno-Economic Networks and Irreversibility.” In *A sociology of monsters: Essays on power, technology, and domination*, ed. J. Law, London: Routledge, 1991, 132-161.  
 [7] Coase, R. “The nature of the firm,” *Economica*, 1937, 4: 386-405. Reprinted in: Coase, R., 1988, *The firm, the market and the law*, Chicago: University of Chicago Press.  
 [8] Czarniawska, B. and Sevón, G. *Translating organizational change*, eds. 1996. Berlin: de Gruyter.  
 [9] DiMaggio, P. J. and Powell, W. W. “The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields,” *American Sociological Review*, 1983, 48: 147-160.  
 [10] DiMaggio, P. J. and Powell, W. W. *The new institutionalism in organizational analysis*, Chicago: University of Chicago Press, 1991.  
 [11] Giddens, A. *The constitution of society: Outline of the theory of structuration*, Berkeley: University of California Press, 1984.  
 [12] Glaser, B. G. and Strauss, A. L. *The discovery of grounded theory*, Chicago, IL: Aldine, 1967.  
 [13] Greenwood, R. and Hinings, C. R. “Understanding radical organizational change: Bringing together the old and the new institutionalism,” *Academy of Management Review*, 1996, 21(4), 1022-1054.  
 [14] Greenwood, R. Suddaby, R., and Hinings, C. R., “Theorizing change: The role of professional associations in the transformation of institutionalized fields,” *Academy of Management Journal*, 2002, 45(1), 58-80.  
 [15] Hoffman, A. J. 1999. “Institutional evolution and change: Environmentalism and the U.S. chemical industry”, *Academy of Management Journal*, 42(4), 351-371.  
 [16] Kelley, S. W. “Efficiency in service delivery: Technological or humanistic approaches?” *The Journal of Service Marketing*, 1989, summer, 3(3), 43-50.  
 [17] Lacity, M. and Willcocks, L. *Best practices in information technology sourcing*, Oxford Executive Research Briefings, 1996, Oxford, England.  
 [18] Latour, B. “The power of associations,” in *Power*,

- action and belief. A new sociology of knowledge? J. Law, (ed.), 261-277, London: Routledge and Kegan Paul, 1986.
- [19] Latour, B. *Aramis or the love of technology*. Cambridge: Harvard University Press, 1996.
- [20] Latour, B. *Science in action: How to follow scientists and engineers through society*, Cambridge: Harvard University Press, 1987.
- [21] Lawrence, T. B., Winn, M. I., and Jennings, P. D. "The temporal dynamics of institutionalization," *Academy of Management Review*, 2001, 26(4), 624-644.
- [22] Lonsdale, C. "Lock-in to supplier dominance: On the dangers of asset specificity for the outsourcing decision," *Journal of Supply Chain Management*, 2001, Spring, 22-27.
- [23] Matthyssens, P. and Vandenbempt, K. "Creating competitive advantage in industrial services," *Journal of Business & Industrial Marketing*, 1998, 13(4/5), 339-355.
- [24] Merton, R. K., Fiske, M., and Kendall, P. L. *The focused interview: A manual of problems and procedures*, 2<sup>d</sup> ed., New York: Free Press, 1990.
- [25] North, D. C. *Institutions, institutional change and economic performance*, Cambridge University Press, 1990.
- [26] Ouchi, W. G. "Markets, bureaucracies, and clans." *Administrative Science Quarterly*, 1980, 25, 129-141.
- [27] Patton, M. Q. *How to use qualitative methods in evaluation*, Newbury Park, CA: Sage, 1987.
- [28] Powell, W. W. "Neither market nor hierarchy: Network forms of organization," In B. W. Staw and L. L. Cummings (eds.), *Research in Organizational Behavior*, 12, 295-336. Greenwich, CT: JAI Press, 1990.
- [29] Scott, W. R. "The evolution of organization theory," In *Studies in organizational sociology: Essays in honor of Charles K. Warriner*, edited by Gale Miller. Greenwich, CT: JAI, 1991, 53-68.
- [30] Scott, W. R. "The organization of environments: Network, cultural, and historical elements," In *Organizational environments: Ritual and rationality*, Meyer, J. W. and Scott, W. R. Updated Edition, Beverly Hills, CA: Sage, 1992, 155-175.
- [31] Scott, W. R. *Institutions and organizations*, London, CA: Sage, 1995.
- [32] Tolbert, P. S. "Resource dependence and institutional environments: Sources of administrative structure in institutions of higher education," *Administrative Science Quarterly*, 1985, 30: 1-13.
- [33] Tolbert, P. S., and Zucker, L. G. "Institutional sources of change in the formal structure of organizations: The diffusion of civil service reform, 1880-1935," *Administrative Science Quarterly*, 1983, 28, 22-39.
- [34] Watson, R. T., Akselsen, S., and Pitt, L. F. "Attractors: Building mountains in the flat landscape of the world wide web," *California Management Review*, 1998, Winter, 40(2), 36-56.
- [35] Williamson, O. E. *The economic institutions of capitalism*, 1985, New York: The Free Press.
- [36] Wise, R. and Morrison, D. "Beyond the exchange: The future of B2B," *Harvard Business Review*, 2000, November-December, 86-96.
- [37] Yin, R. K. *Case study research: Design and methods*, 2nd Ed., London, CA: Sage, 1994.
- [38] Zucker, L. G. "Institutional theories of organizations," *Annual Review of Sociology*, 13, 443-464, 1987.

# Approach to E-Business: A Case Study of Shanghai Tobacco Group Corporation

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## Abstract

With the fast development of Internet, e-Business is prospering in the recently five years. Many traditional companies have been convinced of this revolutionary change, and they are exploring a feasible way to adapt to the transition. Chinese companies have weaker bases than the developed countries, but they are also cognizant of the big trend, and are making great efforts to grasp the opportunities. This paper introduces a practical Chinese case that illustrates the increasingly strategic role of e-business applications in traditional manufacturing industries. The company we studied is a large Chinese tobacco corporation, which locates in Shanghai, one of the most developed areas of China. After the WTO entry of China, the regulation system of Chinese tobacco industry will be transformed from STMA (State Tobacco Monopoly Administration) to a more open one. This will bring about more competitive pressures to Chinese tobacco enterprises. How can traditional large corporations adapt to the real new economy in the new environment, it is a big problem that most of the Chinese tobacco corporation faced on. Sensing the challenges and opportunities, Shanghai Tobacco Group Corporation started to search after a new development way, and they intend to develop an e-business application model to improve its distribution processes to integrate their purchasing, manufacturing, delivering, logistics, and sales. Studying such a typical large company, it may be helpful for other large company in other industry.

This paper first reports the background of Chinese tobacco industry and a brief history of the IT applications in Shanghai Tobacco Group Corporation (in the next part we use SHTG for short), then we discuss the environment and business factors that led to the e-business application. Based on the above introductions and discussions, we illustrate an e-business solution to handle the situation SHTG faced.

Keywords: e-Business Model; E-Business applications; Enterprise Information System; Strategic Information Systems;

## 1. Introduction

Information technology (IT) is transcending its

traditional back office role toward a strategic role in the recent years. It has been successfully applied by many companies to increase their competitive advantages [1,2,3,4]. It plays more comprehensive roles in wide scopes of business domains than before. In business world, IT does not only reduce the corporation's cost and increase its efficiency, but also change the industry structure, the rules of competition and the organizational structure [2,5,6,7]. In past twenty years, the rapid growth of the Internet and Internet based applications is stimulating an ever-increasing number of businesses to participate in e-business worldwide. For Example, United Parcel Service, Dell Online, Ford Motor Company, Seven-Eleven Japan, and etc., they are the well-known companies who pioneered e-business applications in their own industries and greatly leveraged their competitive competence by use of IT. E-business is one of the hot application areas of today's business, and it shapes a new landscape of business competition.

In this paper, we will introduce a practical case — Shanghai Tobacco Group Corporation (SHTG) and explain how and why SHTG expends its IT to the domain of e-business applications and integrates the operations of the company with its enterprise-wide information system.

In the first part, we will give a brief introduction on the background of Chinese tobacco industry and a brief history of information system applications in SHTG. Next, we will introduce the current situation of SHTG's IT applications. In the third part, we will discuss the problems SHTG faced in today's environment of running businesses and what will happen after the China's entry into WTO. Based on the above introductions and discussions, an e-business solution to handle the situation SHTG faced is introduced. In summary and discussion, we will discuss the significance of this case study.

## 2. Background

### 2.1 Background of the Industry

The China's tobacco industry is regulated by the system of state monopoly administration. All the tobacco related operations, such as growing tobacco leaves, cigarette manufacturing, distribution and sales, are all

regulated by the State Tobacco Monopoly Administration (STMA). STMA exercises a strict control role over tobacco production by planning. Tobacco makers have to coordinate their production in line with the production quotas issued by competent administrative authorities. Under this system, the tobacco production and sales are regulated and protected by the Tobacco Monopoly Law. Furthermore, the Chinese tobacco wholesale and retail markets are also protected by the government by measures such as the restriction of tobacco import, the imposition of high import duties and the establishment of non-tariff trade barriers. Table 1 is the Chinese import duties rate of tobacco related products in 2001. Compared with other industries, tobacco industry is a closed one.

Table 1 The Chinese import duties rate of tobacco related products in 2001

Tobacco related products	Import duties rate (%)
tobacco leaves	34
homogenized or “reconstituted” tobacco (such as strips)	54
tobacco	57
cigarettes	65 (regulation rate) and 36 (effective rate)
cigarette paper	45

China’s tobacco industry has experienced a long period of prosperity. According to the STMA’s statistics, Chinese tobacco industry has provided an accumulative 697.4 billion Yuan RMB for the country over the past ten years. Some 10 percent of the revenue for the national finance and taxation comes from the tobacco industry in China.

Undoubtedly, SMA system and protection from the government play key roles behind the prosperity and success of the tobacco industry. The success of a tobacco enterprise is guaranteed by output quotas, which is assigned by STMA. Therefore, manufacturers primarily put their main resources on their production and product quality.

## 2.2 A Brief History of SHTG’s IT Applications

The IT history of SHTG started from the late years of 1970s when it was still Shanghai Cigarette Factory (SHCF). At that time, it introduced single-chip computers in the application field of process control in 1978, which aimed at automating its manufacturing process for cigarette manufacture. In 1982, several microcomputers were put into use in the management areas, such as the allocation of worker force, payoff accounting and cost accounting. And then SHTG expended its IT application

into the domains of inventory management and financial accounting. In this period, all the applications of IT in SHTG were isolated systems. Their functionalities were limited to the organizational units where they were deployed. What they did in IT deployment was just embedding the existed processes in silicon and software<sup>[7]</sup>. However, the situation of SHTG’s IT was in line with its need of IT. Because what it focused on in business operation at that time was to improve its efficiency in production and lower its operational cost under the protection from SMA system.

At the late of 1980s, having seen that IT had expended to many operational units and considering the future trends of IT applications, SHTG decided to leverage its IT applications to a new level. The establishment of a network based on Novel structure in 1987 started its attempt toward this goal. What SHTG had done first was to establish a network within SHTG so as to integrate all of these applications and facilitate communications among different applications.

Entering into 1990, an excellent opportunity for SHTG of fast development came when Shanghai’s Pudong area was established as a developing zone by the central government. Shanghai was opened wider to the outside. Shanghai has gained the focus from the whole China and the world. Many foreign companies flushed into Shanghai to establish their own branches or invest to create a new one. In 1993, SHTG was founded, and the scale of the corporation increased many times compared with SHCF. Besides SHCF, SHTG includes other enterprises, sub-companies and holding companies, e.g. the Tobacco Trading Center, tobacco leaf grow bases (13 in total), Guanshenyuan Food (Group) Corporation and others. Its business scope expanded from tobacco related products to food, drinking, real estate, transportation and others. Its enterprises cover many parts of China, for example SHTG cooperates with other 15 tobacco limited companies distributed in different provinces of China. With the incentive from the managerial abilities of European and American companies and increasingly intense competitiveness among Chinese tobacco market, SHTG felt an urgent need to leverage its ability to manage such a large scale group corporation and to enlarge its market share.

## 3. Current Situation of SHTG’s IT: Enterprise Information System

### 3.1 Structure of Current Information Systems

In the middle of 1990s, SHTG set up a information system plan, which outlined its blueprint of enterprise information systems and proposed a schedule to implement it during a five-year period. Several partners

from the tobacco industry and IT industry were included in the development of the application systems. The subsystems such as executive information system (EIS), row material management (RMM), inventory management (IM), coding management (CM), auxiliary material management (AM), manufacturing schedule (MS), quality control (QC), cost control (CC), equipment management (EM), statistical analysis (SA), data capturing and collection (DCC), finished goods circulation (FGC), comprehensive statistical processing (CSP), financial accounting (FA), human resource (HR), intranet and office automation (OA) have been implemented and put into use in SHTG. Figure 1 show the structure of SHTG's enterprise-wide information system. These systems were developed in hope that the deployment of IT would help the corporation to realize its strategy of leveraging its managerial competence.

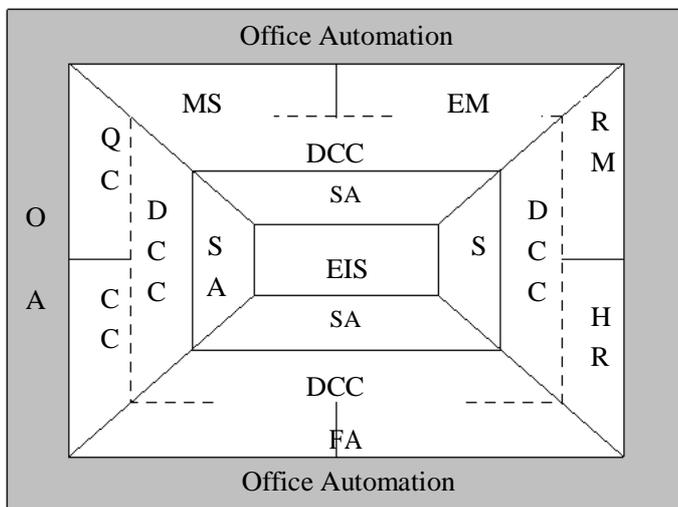


Figure 1 A IS pyramid structure of SHTG

Figure 1 shows that there are four levels in the IS pyramid structure of SHTG. They are divided into four different level: Decision Support Level, Information Services Level, Transaction Processing Level and Office Automation Level, from the top (center of the diagram) to the bottom (out ring of the diagram) separately.

- In Decision Support Level, EIS provides information for executives of every managerial level. It is the top level of all the applications;
- Information Services Level is a mediate layer between EIS and other lower level subsystems. It captures and processes data from its sub-level applications. It provides statistics analysis to all subsystems and it is actually incorporated in the subsystems. But it is logically independent from its incorporated subsystems;
- Transaction Processing Level, the third layer of the pyramid structure, is made up of the

different functional subsystems as mentioned above. These subsystems are applied in specific application fields separately. Different systems use different processing approaches and generate a large amount of different data, both structured and non-structured, and they are essential to the decisions of executives. These subsystems are the main body of SHTG's IS that supports the daily operation of SHTG;

- Office Automation Level is a level to support the office automation for middle executives. It is a channel for information transformation. It is logically the infrastructure of the whole information system as showed in figure 1.

Furthermore, the system not only facilitates internal communication of everyday operations, but also helps the company acquire the external information, for example, it links with the other intranets of SHTG, and connects to Internet.

### 3.2 Benefits from IT Applications

The existed information system covers the main value chain of SHTG. In manufacturing, it provides the function of manufacturing schedule, quality control, cost control and equipment management systems. In material supply and inventory aspect, it integrates the row material management, inventory management, coding management, auxiliary material management and finished goods circulation systems. In management domain, it has the function of statistical analysis, human resource management, financial accounting, and office automation systems. The implementation of these systems bring benefits to SHTG in the following aspects:

- Facilitating the communication throughout the group;
- Having the first-hand information when market changes;
- Lowering inventory level of row material;
- Improving managerial efficiency and productivity;
- Supporting decision making for the top executives of the group;
- Improving skills of all end-users in using computer; and
- Leveraging IT competency.

## 4. China's WTO Entry — Changing the Competitive Rules

At the beginning of the new century, China welcomed a historical turn — she joined the World Trade Organization (WTO) on November 10, 2001. However, it is not a good news for the Chinese tobacco industry.

China's tobacco market will further integrate itself into the world's free trade system characterized by open international business competition. For the Chinese tobacco industry, how it reacts after the WTO entry has become an issue of great concern.

Though according to the agreements, STMA can still temporarily apply the Tobacco Monopoly Law after China's entry into WTO, China will lower the tariff on tobacco imports eventually. On the other hand, STMA has to reform itself to adapt to the free market environment. Its regulation over the tobacco manufacturing and sales market will be more loose and indirect. Generally speaking, China's WTO entry will bring great pressures to the tobacco industry. Homemade cigarettes and foreign cigarettes will compete fiercely as soon as China releases down many regulations. In the wake of global competition, Chinese tobacco industry is expected to choose either to catch up with the steps of the counterparts in advanced countries or to give up and be driven out of the industry, as the superior will survive while the inferior will die. For the tobacco industry, the good times of being cosseted under the protection of the government will go away.

### 5. The Solutions of SHTG to Face the WTO Entry Challenges

To respond to the challenges imposed by WTO entry

and the changes of domestic market, SHTG sets its corporation strategy with the support of IT. Concerning that production could not guarantee the success in the future tobacco market any more, SHTG turns its strategic focus on marketing—a lesson it must learn in the new industry environment. Establishing a new marketing network to maintain its market share is in its agenda, an e-business solution is therefore proposed.

#### 5.1 The current market channel and selling chain

Figure 2 illustrates the current selling chain of cigarettes sales in SHTG. Its customer can be generally classified into three groups: local customers, domestic customers and international customers. They are accessed through different market channels.

Local customers refer to the customers within Shanghai area. They can be accessed through the Cigarette Wholesale and Retail Net of SHTG. They are the only customers who can be reached by the net so far. Cigarette Wholesale and Retail Net of SHTG has more than 24,000 members distributed in the whole Shanghai area. Among them, there are over 600 shops directly belong to the sub-branches of SHTG, over 1,000 chartered shops belong to the top 8 supermarkets in Shanghai and more than 20,000 retailers. They are all licensed by SMTA.

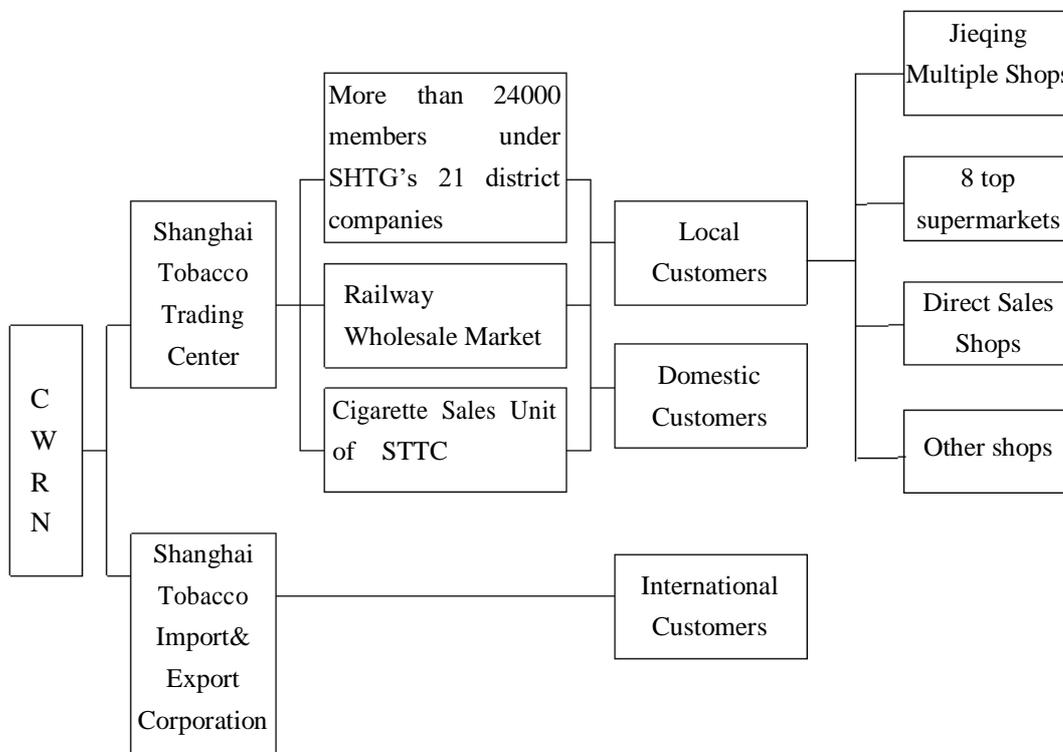


Figure 2. Current wholesale and retail network of SHTG

Domestic customers refer to the domestic customers outside Shanghai area. They are can be accessed through orders from other provinces. The orders can be obtained in the tobacco trade fair, which hold twice a year. Though the orders obtained could be varied in terms of quantity and other transactional details such as finish time and transportation means each year, the total quantity of production output can not over-fulfill the quota issued by SMTA for the enterprise each year. So the vary in orders would not influence the total requirement.

International customers are accessed through the orders from the sub-branches of Shanghai Tobacco Import and Export Corporation (STIEC). The production output for the orders should be planed according to the plan set by the Foreign Trade Ministry of China. These orders would not influence the total requirement as well.

### 5.2 E-business Based Model of Marketing and Selling Chain Management

The above introduction shows that SHTG has a long selling chain, e.g. the customer can be reached only via

many intermediaries. Its sales net structure is complicated comparably. Its customer profiles are different, too: they are located at different part of the country (e.g. countryside, city), and in the different walks of life. As regard to the WTO entry and the changes of domestic market, it is imperative to integrate all its existed market channels so as to make it works in a more efficient way. Put it specifically, SHTG need its CWRN to achieve the following goals:

- Making best use of the existed CWRN, e.g. fast respond to the requests from its retailers and distributors;
- A mechanism to manage its relation with its customers (CRM);
- A better way to promote its products; and
- Expanding its existed CWRN, which covers only Shanghai area now, so that the other regions can be reached.

Based on above requirements, an e-business based model of marketing and selling chain management is articulated, as Figure 3 shows it.

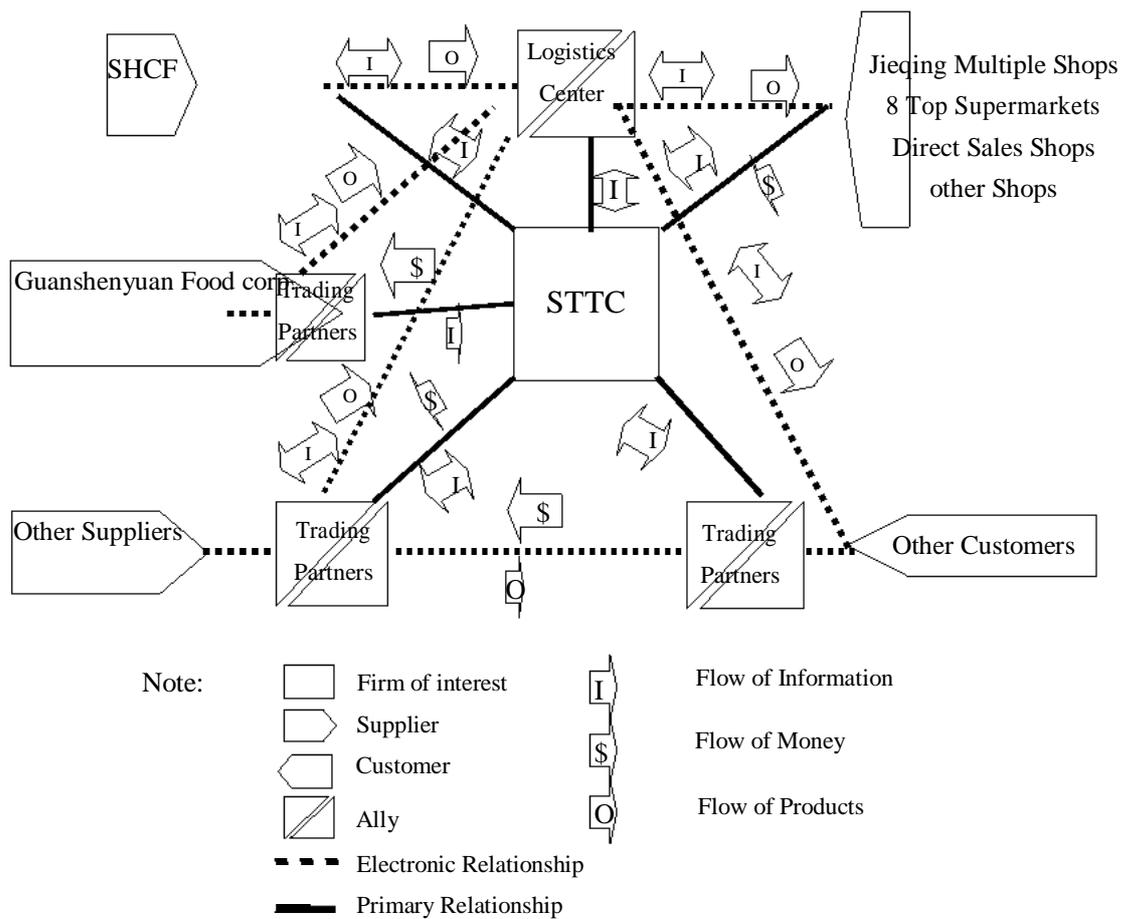


Figure 3 An e-business based model of marketing and selling chain

### 5.3 Value Net Integrator and Sales Channel Integrator

Shanghai Tobacco Trading Center (STTC) is an organizational unit of SHTG and it will act as the core unit for all e-business-related applications in SHTG. It also acts as value net integrator [9] and sales channel integrator in SHTG. As a value net integrator, it is the core unit for all sub-corporations of SHTG. It will integrate the whole value of the corporation through collecting, integrating and distributing information that is distributed in the different value activities of value chain [3] in whole SHTG. As a sales channel integrator, it will integrate all sales channels in SHTG through the coordination of sales activities in the selling chain.

For example, by viewing the information related to the inventory of its subordinated shops via a POS, which is connected to the STTC, the top executives of SHTG can easily know the sales performance of the shops, and then with the support of data mining systems, the top executives can also know the consumer behaviors. With this information, the top executives can easily know what and when the customers need, and then decisions can be made rapidly and automatically. The STTC can also integrate information about suppliers and forward it to the customers, or in reverses, prepare information related to customers for suppliers. In doing so, the STTC also acts as an information integrator.

The model is hoped to support the corporation to carry out its corporation strategy goal of being a value integrator of the industry in the following aspects:

- Coordinating the relationship among the members linked by selling chain by conducting

the activities of capturing, collecting, analyzing and distributing information;

- Strengthening its “core” position in the selling chain, so as to leverage its competence in information accessibility; and
- Facilitating the corporation with other enterprises, improving the efficiency of the selling chain.

### 5.4 Single Contact Service

SHTG is a comprehensive corporation. Besides tobacco related products and services, it also provides other products and services, e.g. sugar, food, drinking, and others. For example, Guanshenyuan Food (group) corporation, which is running in the food industry, is one of its holding companies. It is necessary for STTC to provide information services not only for tobacco related products and services, but also for other products and services as well. So the STTC will be implemented as an integrated platform for SHTG to carry out its all operation activities. The single contact service model provides a better solution to this requirement.

By single contact service solution, STTC will integrate all information services in a platform so that it can improve the internal operation environment and different business units can exchange information efficiently in SHTG. As regard to the customers and suppliers, it will provide a “total solution” for them — get all they want and finish all the transactions at a single point.

Figure 4 gives the main frame of e-business based selling chain model of SHTG. It illustrates the above ideas.

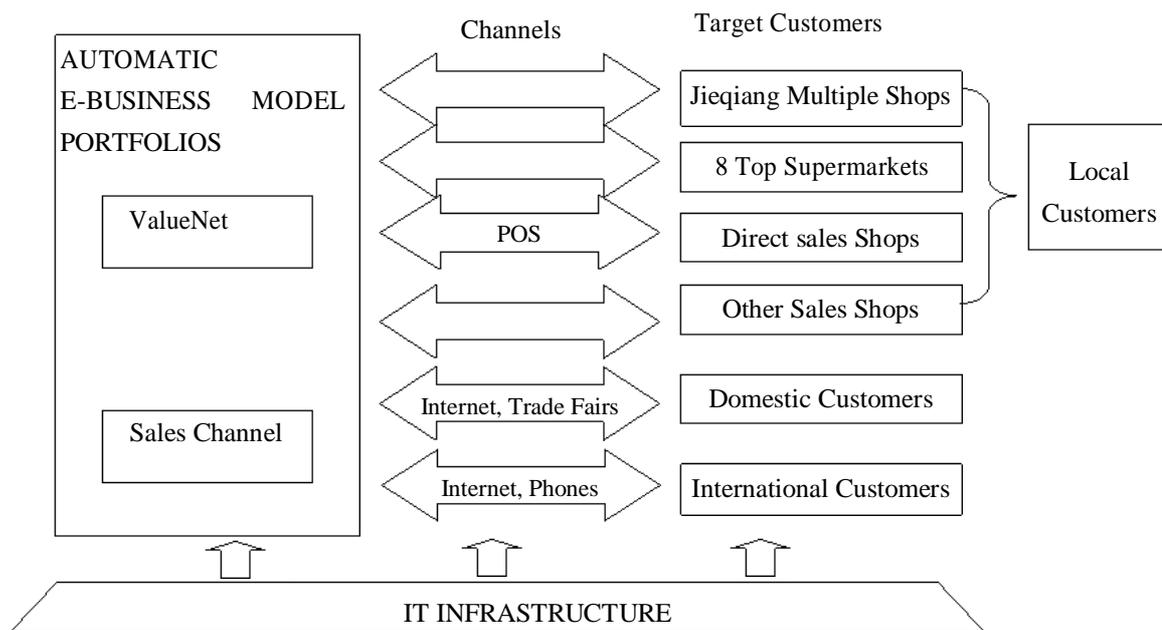


Figure 4 Mainframe of e-business based selling chain model of SHTG

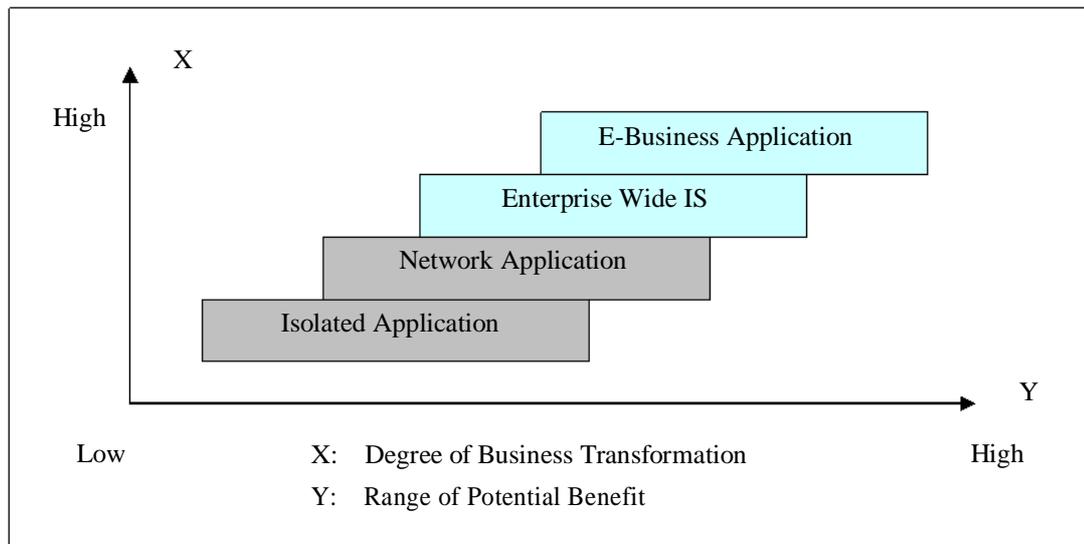


Figure 5 SHTG's IT application trajectory

## 6. Summary and recommendation

In this case study, we illustrate the roadmap of SHTG to e-business. Figure 5 outlines SHTG's IT trajectory. Following the framework developed by Venkatraman[6] and Davidson[10], we can observe that SHTG's current IT is at the phase of business redefinition. Therefore, it is inevitably that great changes will happen in the organizational structure and processes. Taking the current problems SHTG facing both in the business domain and external environment domain into account, several beneficial conclusions can be reached for SHTG.

- It is imperative to settle the contradiction between the operation in the SMA system and the operation in the open tobacco market, e.g., transform from production oriented management to marketing oriented management and make its organization system closer to the market;
- It is imperative to accomplish the innovation of the organizational form and mechanism;
- It is imperative to thoroughly reform the current system of internal institutional establishment, management system and distribution system of enterprises.
- It is important for the top executives to recognize the inevitability of changes to the organization when IT is deployed if SHTG want its investment in IT will deliver desired benefits to the organization.

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## References

- [1] Henderson, J. C. and Venkatraman, N., Strategic alignment: Leveraging information technology for transforming organizations, *IBM Systems Journal* 32(1), 1993, 4-16
- [2] Porter, M. E. and Millar, E., How Information Gives You Competitive Advantage, *Harvard Business Review*, July-August, 1985, 1-13
- [3] Porter, M. E., *Competitive Advantage: Creating and Sustaining Superior Performance*, New York, Free Press, 1985
- [4] Clemons, E. K., Information systems for sustainable competitive advantage, *Information & Management*, 11(3), 1986, 131-136
- [5] Luftman, J. N., Lewis, P. R. and Oldach, S. H., Transforming the enterprise: The alignment of business and information technology strategies, *IBM Systems Journal*, 32(1), 1993, 198-221
- [6] Venkatraman, N., IT-Enabled Business Transformation: From Automation to Business Scope Redefinition, *Sloan Management Review*, Winter, 1994, 73-87

- [7] Hammer, M., Reengineering Work: Don't Automate, Obliterate, Harvard Business Review, July-August, 1990, 2-8
- [8] Kalakota, R. and Robinson, M., e-Business 2.0: Roadmap for success, Addison Wesley, 2001
- [9] Weill, P. and Vitale M., From Place to Space: Migrating to Atomic e-Business Models, Harvard Business School Press, Forthcoming, 2001
- [10] Davidson, W. H., Beyond re-engineering: the three phases of business transformation, IBM Systems Journal, 32(1), 1993, 65-79

# Offline Empowerment: Key to the Success of E-Business in India

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## Abstract

This paper deals with empowerment of the offline customers (who are responsible for 99% of retailing), to have the benefits of being online and have all the shopping experience, in fact, with a greater presentation appeal.

The models proposed here bypass all the above limitations and gives any customer an online shopping / subscription experience, even without the knowledge of operating a PC.

This “Offline Empowerment I” also deals with the other mentioned problems by: presentation enhancement, bypassing connectivity, reducing security hassles etc.

This is achieved by some technical and logical segregation of presentation layer and business logic layer across the Internet. Thus, removes the bottlenecking in the adoption of e-shopping, paving way for a greater E-business.

Of course, the rewards depend on the successful implementation of the presentation logic, business logic and the overall strategy.

## 1. Introduction

A nation with diverse tastes and preferences, India, has globally been recognized as a source of skilled technical manpower. With the advent of Information technology, Indian industry and manpower, to a greater extent, have geared up themselves in this promising area to transform their businesses on Internet. But, with a heap of promises and predictions, it is evident that the E-Business didn't come up to the desired levels.

Generally, there are various reasons attributed to it:

- Downward trend in economy
- The rapid technological changes difficult to keep pace with.
- Non-feasible business models,
- Lack of awareness in customers.
- Security concerns etc.

Let's have a look at the data by TNS Interactive - Global eCommerce Report - June 2002 India:

[1]

Data collected in 4 largest cities.

Percentage of total population who are Internet users

Year 2000 = 10%

Year 2001 = 13%

Year 2002 = 16%

Male = 24%

Female = 10%

Online Shoppers

1% of surveyed total population

4% of surveyed Internet Users

Main reason for not buying online (in India)

Too difficult / lack of knowledge

In a developing region like India, the growth of Internet user has not attained a substantial maturity, owing to many of the reasons like: Internet awareness and connectivity. Corporate bodies will have to use the power of the Internet to correct inefficiencies in the value chain, transform the role of the company to managing the value chain, device strategies to cut costs and improve business processes.

M E Porter has rightly identified the “... Need to create strategies that involve new, hybrid value chains, bringing together virtual & physical activities in unique configurations”. Competitiveness in E business can only be achieved by a strong business model, which in turn consists of efficient business processes. Therefore, at the micro level, it is actually the business process that is making a particular model feasible, strong and effective. This business model should stand in unison with the efficient processes as well as the technological implementation of the model. The Internet channel of tomorrow will largely be a hybrid one with customers seeking value at the lowest cost from each component channel. Companies that realize this & modify their channels appropriately are likely to benefit the most from the introduction of Internet into retailing.

The net has helped reach the customer directly circumventing the two traditional indirect buffers - mass, media & retailers. Hence, it can work as a medium of communication and to business with. E-tailing, however, appears to be a couple of years away. Today, E-retailing comprises less than 1% of retail sales in the USA & much less in India.

Therefore, in the Indian context it becomes really essential to target the offline masses to be enabled by Internet based shopping experience. But the following are the limitations:

- Poor knowledge for operating a PC.
- Lack of awareness about Internet.
- Inherent fears about security.
- Slow connectivity - a major hurdle in e-shopping.
- Internet is not being utilized as an effective media of presentation, which is required for powerful sales closing.
- Diverting the customers from traditional channels to online.

This paper deals with empowerment of the offline customers (who are responsible for 99% of retailing), to have the benefits of being online and have all the shopping experience, in fact, with a greater presentation appeal. The model proposed here bypasses all the above limitations and gives any customer an online shopping experience, even without the knowledge of operating a PC.

The "Offline Empowerment model" also deal with the other mentioned problems by: presentation enhancement, bypassing connectivity, reducing security hassles etc. This is achieved by some technical and logical segregation of presentation layer and business logic layer across the Internet. Thus, removes the bottlenecking in the adoption of e-shopping, paving way for a greater E-business. Of course, the rewards depend on the successful implementation of the presentation logic, business logic and the overall strategy.

## 2. Offline Empowerment

Consumers expect the same experience and the same answer anytime, anywhere, anyhow... their choice... are we consistently offering our customers the convenient, easy and enjoyable shopping experience they expect?

The notion of "Offline Empowerment" is aimed at providing the benefits of Information & Communication Technology to the masses, in Indian context it refers to developing the processes suited to the needs of those people who are 'offline and not computer literate'.

In this paper we will postulate two approaches towards the "Offline Empowerment":

- The Virtual Show Room Model.
- The Offline Enterprise Model.

Years 2000-2002 have witnessed a gloomy phase in the E-business scenario all over the world. Economic values of the companies eroded, the basis of competition shifted, new business alliances evolved and perished, and it became harder for anyone in their industry to turn a profit. Electronic commerce is changing the shape of competition, the speed of action

and nature of leadership. Managers everywhere are feeling the heat. The companies are at E-commerce crossroads and there are many ways to go. But which road will lead to success? Which business models, management strategies & tactics will make them successful?

According to a recent study by Confederation of Indian Industry (CII) & the consultancy company PriceWaterHouseCoppers, the total E-business in India is expected to be worth Rs 55,000 crores by year 2005. Thus, the Indian corporate are also reassessing their expectations of E business. Corporate can use the power of the internet to correct inefficiencies in the value chain, transform the role of the company to managing the value chain, device strategies to cut costs, improve business processes, and to look at greater transparencies among the business partners. [2]

The basis of competition & wealth creation in the digital economy is not only good use of information, quality, speed or effective decision-making, but it is business model innovation.

Competitiveness in E business can only be achieved by a strong business model, which in turn consists of efficient business processes. Therefore, at the micro level, it is actually the business process that is making a particular model feasible, strong and effective. This business model should stand in unison with the efficient processes as well as the technological implementation of the model.

## 3. Making it Click

The Internet channel of tomorrow will largely be a hybrid one with customers seeking value at the lowest cost from each component channel. Companies that realize this & modify their channels appropriately are likely to benefit the most from the introduction of Internet into retailing.

The net has helped reach the customer directly circumventing the two traditional indirect buffers - mass, media & retailers. Hence, it can work as a medium of communication and to business with. E-tailing, however, appears to be a couple of years away. Today, E-retailing comprises just about 0.89 % of retail sales in the USA & much less in India. [4]

There has been a fundamental flaw in one of the assumptions of E-retailing that everything could be sold online profitably and to anybody.

A recent study has predicted that E-commerce in India will jump from between Rs. 25 crore & Rs. 28 crore in 2000 to Rs. 220 crore in 2001. However, the study also points out to the fact that certain barriers need to be surmounted to exploit the potential of E-tailing. The first and foremost is the fact that there are only 5 million net users in India, out of whom only 2 millions are active. Besides 75% of net users are males.

Secondly, wide range of products usually has to be delivered offline and in the shortest time which makes managing the supply chain, a nightmare. Thirdly, with low margins on a variety of products, especially FMCG products (about 5 -10%), deep discounting may not be possible on the net. [5]

We will have to give some way to pragmatism by pondering on the issues like: What kinds of shopping activities are likely to make consumers migrate to net? How do shoppers compare and contrast their shopping options? Will e-retailing and net usage increase or decrease among different segment of customers?

Such perplexities of consumer behavior are hardly a new phenomenon. Traditional marketers have always been thrashing such problems even before the emergence of the Net and online shopping. But, out of that effort came a sophisticated understanding of the context in which a buying decision occurs, an understanding that is as valid online as off.

It is true that customers buy different products for different reasons at different times. This seems obvious. But the profile and indiscriminate use of online marketing tactics for all types of online consumers - regardless of their awareness level, interest and buying behavior - shows that many online marketers don't quite get it.

Through trial and error or sheer luck, some online marketers have achieved impressive results with these powerful new tools. But between their rush to adopt these tools and their over-reliance on data about Internet purchasing, online business-to-consumer marketers have tended to ignore some fundamental truths about consumer behavior. And without a full understanding of these truths, the promise of E-marketing in the B2C sector will largely go unfulfilled.

#### 4. Virtual Showroom model

In the contemporary attempt, I am presenting a business model consisting of some business processes being conceptualized on the fact that Internet is largely a presentation medium for the sale of a product. Business operating in today's economy can thrive only when they approach electronic commerce with the customer in mind. This means knowing how, when and why they shop and what their motivations, emotions, expectations and fears are.

We all know that books and CDs consist of a lion's share of the products sold online; both of these products do not require the utilization of an efficient presentation. The question is that, are we not able to fully utilize the presentation capability of Internet or the presentation capability of Internet is impoverished?

I quote her AIDAS theory of sales that stands for Attention, Interest, Desire, Action and satisfaction. [6]

We can realize the importance of creating attention, which invokes interest in the product and ultimately leads to sale. Attention, being a strong prerogative for sale goes hand in hand with interaction of the customer with the product, features and specifications.

Now imagine the customer with a desktop PC, who is browsing the internet over a dial up connection, struggling hard to download a single small size two dimensional static view of the product along with written specifications. Again & again he has to wait, if at all he has to accomplish a purchase. This selling process is largely driven by the customer's initiative & he is being repeatedly asked to click here and there. Unguided by any sales man & immediate query quenching, he finally types out some different URL in the browser's address box & presses GO.

A poor point of purchase strategy and hence even less than 1% of retailing is E-retailing. Nonetheless are hassles of credit card, security, passwords etc.

The virtual showroom model deals largely with presentation enhancement, hence increasing the attention and interaction resulting into higher probability of sale.

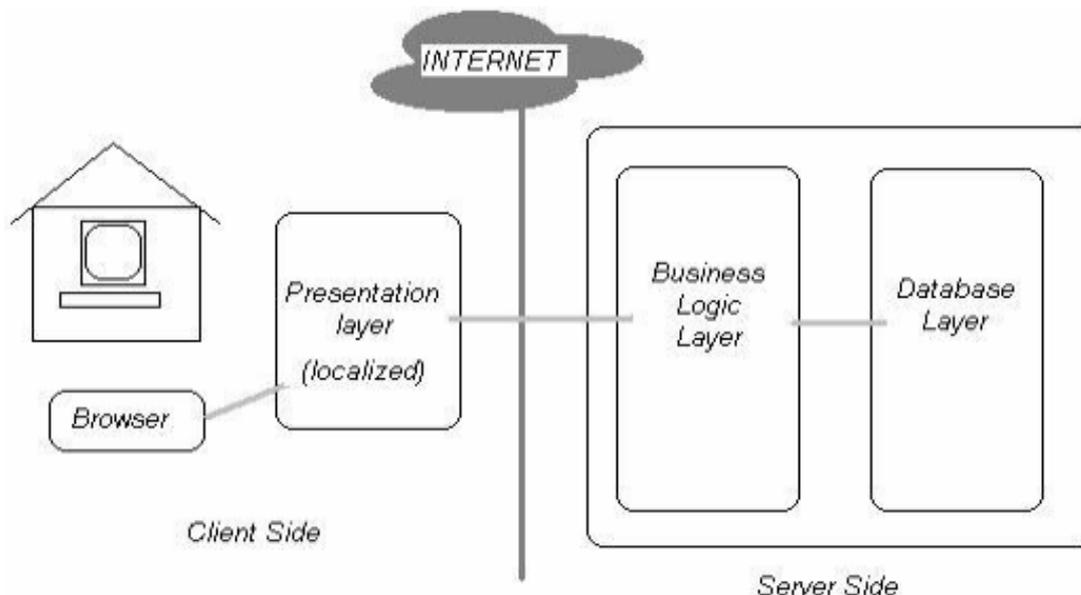
Lets first have a look at the existing web application system, which consists of three tiers namely the client, the middle tier and the backend (database layer). The client is connected to the middle tier via Internet. This middle tier (server) is actually hosting the presentation layer and the business logic layer.

Now a potential customer who is browsing the website is constantly interacting with the presentation layer of the middle tier; connectivity being Internet. This presentation layer is very important and the only media in the hands of a marketer online.

Ever experienced the downloading patience required for a graphic file? Streaming video and audio are still a distant dream says an Internet advertising consultancy, Jupiter- "Widespread use of streaming video and audio will depend on high speed net connections, which aren't expected to be adopted by a critical mass of household (30 million) until 2005" [7]

Then what will happen to our "presentation enhancement", "audio-video interaction" and better attention? The answer lies in the localization of the presentation layer. Once the presentation layer is localized then we exploit the best possibilities of a desktop PC for greater interaction. Also, we can take the much required "Human touch" in the sales process.

To achieve this, the virtual showroom model utilizes product catalogue demonstration software recorded on a compact disk, which the company's business partners will use for the virtual showroom display. (see fig 1)



## 5. Virtual Showroom model operationalized

The business firm based on this model will seek its business partners (franchise) like departmental stores, other outlets etc. By doing so, the firm is actually utilizing the existing customer base of the departmental store.

A PC along with a big display, full multimedia, touch screen etc will be installed at the departmental store for a virtual showroom setup. The business partner will divert the potential customers to this showroom setup where they will be interacting lively with the product features. E.g. In the “clothes and apparel” section of virtual showroom, we can see a full video of a model sporting the chosen outfit etc.

The Virtual Show room Model (fig 1)

Now with the help of this software on the demonstration CD, the customer will navigate through the showroom, also a real salesman will assist him. This PC is connected to Internet. As soon as a customer goes for a purchase, the order is processed via an e-mail to the parent company’s server. Thus the order is processed and the commodity can be delivered soon.

Also, there are no hassles of insecure money transaction as the business partner would be accepting the cash and will issue the receipt (business partner being the same trusted store of the customer). Off course money can be transferred to the parent company’s account via online account transfer facilities viz ICICI etc.

## 6. Advantages of the model

- Encashing the existing the customer base of the business partner into the segments of associated

product or differentiated product. E.g. Purchasing the car accessories like stereo system, interior furnishings etc. online, after purchasing a car.

- Added “human touch” for powerful sales closing which is not available conventionally.
- Greater interaction, increased attention.
- Secure money transaction (for the end customer)
- Better logistic support can be provided if the transportation can be outsourced and insured.

## 7. Offline Enterprise Model

The Virtual Showroom dealt with the presentation enhancement and slow connectivity while the Offline Enterprise model talks about yet another hinderance in the way of E-Business in India "The large number of potential customers who are off Line"

No E-Business can survive in the long run by targeting only 1% of the total population who are online. We will have to develop some configurations so as to include those people who are 'offline and not computer literate'.

The Offline Enterprise Model is a generic model which is for information based portals, it lays emphasis on the offline presence and operations of any business entity. I will explain this model by an illustration. Think about online job search databases, matrimonials etc which are primarily information disseminators. Now the persons using these facilities are supposed to be online and first of all computer literate, what about those millions who are not?

They are not able to take the advantage of the online aggregation of centralized data. Also the online databases exclude the large offline information which is otherwise available in print media etc.

For such models, there is no bridge between the information online and offline. The information which is online remains online and the information which is from offline sources remains there.

Offline Enterprise model deals with this disparity by bridging this information barrier. You need to catch the offline audience with some offline presence. Recall the case of Online job database. The clients of this business are distributed in the following ways :

- Big Companies jobs are listed online.
- Many of the jobseekers are also online.
- Much larger number of small to middle firms job listing are not online
- Large number of jobseekers are still not online.

How about developing a business process where these four segments can come on a common platform, the unique fusion of Offline and Online. Let us see how the business takes shape after applying the Offline Enterprise Model.

A web based portal will continue to be the source of information dissemination for online listed companies and job seekers. Simultaneously the Enterprise will have Offline presence for the purpose of data collection and generating the offline clients.

This way the portal has listed the data of Online companies and offline companies and firms(which were previously dependent only on print media for publishing the job)

Now the job seekers who are online do have a option of continue searching the jobs online. Moreover, the job seekers who are offline can be sent a customized news letter, generated according to their own profile i.e Qualifications, skills, experience, age etc. (Imagine the appointment section of the newspaper with only the job listings suitable for you). Offcourse the job database portal will charge the subscription fees.

Advantages of The Offline Enterprise model:

- Bringing the two worlds together.
- Large number of potential customers.
- Greater customization which is otherwise not seen in Offline media.

Thus, we see that the concept of “Offline Empowerment” can not only nucleate some unique configurations for the E-Business models but can also be used to cater the requirements of the large number of offline Indian population in various ways. The above two models are generic in nature and can be applied to several business concepts. The success of the application will certainly depend on the effective deployment, robust planning and operations.

## References

- [1] TNS Interactive.Global eCommerce Report - June 2002 India
- [2] India e-business outlook, Sept 2001
- [3] M E Porter -“Strategy and the Internet”. HBR March 2001
- [4] Indrajit Gupta - “It all hinges on the customer now”. Business World 12th Nov 2001
- [5] “Internet in India - 2000”, A study by an e-technology group@ IMRB quoted in Business World, 19th March 2001.
- [6] Cundiff, Still and Govoni - “Sales Management”. EEE. PHI
- [7] Heather Green and Ben Elgin - “Do e-ads have a future”. Dataquest 28th Feb 2001

# Cost-Benefit Analyses of Internet Investments

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## Abstract

“Do we get value or money?” or “Do we have an attractive ROI?” are vital questions that any organisation is encountering today in pursuing an exploitation of the Internet. No matter whether exploitation is in regard to a focus on internal efficiency or external effectiveness the organisation carefully needs to verify the investment in terms of expected costs and likely benefits.

The research question of the paper is to identify the different approaches to cost-benefit methods of Internet investments and to provide an overview of what the approaches sheds light upon. Moreover, the paper provides two examples of cost-benefit analyses. Finally, the paper provides a applicable short-list of important activities and decisions in a cost-benefit analysis.

The paper suggests that cost-benefit analyses should not only contain content variables, but also include flow variables of the communication process, i.e. the variables of volume, data integration, diversity and span.

## 1. Introduction

Investment analysis in information systems is not a new focus area, neither for researchers and consultants or companies and organisations (Hamilton & Chervany 1981, Willcocks 1994). It is nevertheless an area in constant development where the methods for evaluation of investments are becoming more and more varied and the technology is developing at a rapid pace. This paper presents an introduction to cost-benefit analyses of Internet-investments. Our ambition is to give the reader a subtle picture of the cost and benefit sides, enable the reader to distinguish between financial and non-financial methods and understand the content and flow variables. Flow variables are also called process variables.

There may be many reasons for investing in information and communication technology (ICT) and especially in the Internet. For an organisation, the arguments may range from operational or tactical to strategic statements, or they may represent a combination – depending on the situation. The reasons why an organisation wishes to invest in the Internet may be:

- $\frac{3}{4}$  Commercial vital reasons, as if e.g. it is vital to the organisation’s core business or in connection with a project activity.
- $\frac{3}{4}$  Enforced reasons, as if e.g. a supplier or distributive trade demands it and has the negotiating capacity to do so.

- $\frac{3}{4}$  Cost saving and/or profit-earning motives.
- $\frac{3}{4}$  Compensation reasons, as e.g. after a burglary or a damaging virus attack.

Irrespective of reasons, it is often a good idea to make a feasibility study of resource requirements and expected output/benefits – i.e. a cost-benefit-analysis.

Just as the reasons may vary, the level of ambition may also be diverse, and in connection with utilising the Internet, the company can choose to focus on information, communication, transaction and/or integration.

Today, several software programmes include very advanced tools to perform CBA’s. It applies e.g. to IT Service Vision in the SAS-package ([http://www.sas.com/offices/europe/denmark/itsv/itsv\\_manager.html](http://www.sas.com/offices/europe/denmark/itsv/itsv_manager.html)).

At several trade associations and consultancy firms, it is possible to download templates with which to perform CBA’s. The EDI-Council’s server e.g. has a direction to EDI-investments (excel format), which can be downloaded through [www.edu.dk/74.htm](http://www.edu.dk/74.htm). The same applies to the American Office of Risk Ass. And Cost-Benefit (see URL: <http://usda.gov/agency/oce/oracba>). An increasing need for visibility of Internet-solutions within a growing number of fields also creates a need to clarify the contributions from the Internet. When the IT-department proposes to upgrade Windows XP, developing a new intranet or supplying all salesmen with a PDA (Personal Digital Assistant) such as Palm Pilot, the question is: “What does the company gain from these investments?”.

## 2. Research Approach

The research task of the paper is to presents an explorative study of cost-benefit analysis (CBA) practice and research.

The research question of the paper is to identify the different approaches to cost-benefit methods of Internet investments and to provide an overview of what the approaches sheds light upon.

The research method is a literature review of cost-benefit analysis highlighting existing research finding and focus areas. Moreover, the paper reviews different approaches to cost-benefit analysis.

Moreover, the paper provides two examples of cost-benefit analyses. Finally, the paper provides a practical short-list of important activities and decisions in a cost-benefit analysis.

### 3. Literature Review

A common definition of cost-benefit analysis is that it maximizes a social welfare function that aggregates unweighted and unrestricted preferences, e.g. Adler & Posner (1999). Moreover, Adler & Posner (1999) argue that constrained cost-benefit analysis is consistent with a broad array of appealing normative commitments, and it superior to alternative methods of project evaluation.

Cost-benefit analysis has traditionally been concerned with the meso- and macro- levels of the economy focusing on the welfare of a defined society (Mishan 1971, Brent 1996). Also, cost-benefit analyses are used in various sectors and industries, e.g. Noy (1999), Honig & Lampel (2000), McDonald (2001).

Cost-benefit analysis is applied to the evaluation of various phenomena (Fischer 1994, Nolan et al. 1999). In particular, cost-benefit analysis is widely used on a micro-level evaluation projects, investments, new businesses, etc. (Ngwenyama 1999, Bleichrodt & Quiggin 1999, De Haan & Mol 1999, Julnes 2000, Lee & Cunningham 2001, Dey & Gupta 2001, Bleichrodt & Quiggin 2002).

Applications of cost-benefit analysis ranges from specific and well defined projects to support decision making to "new" management problems within enterprises such as improvement of the quality of working life (De Haan and Terra, 1988), advanced manufacturing techniques (De Haan and Peters, 1989), and environmental management (De Haan and De Groene 1993, Yedla & Parikh 2001).

De Haan & Mol (1999) argue that there are two basic principles for cost benefit analyses at the level of the firm. Firstly, any measure to improve the performance of a firm can be seen as an investment and thus should be evaluated accordingly. Secondly, only changes in the relevant items caused by the measure have to be taken into account.

### 4. Cost Benefit Analysis

One perspective argues that often Internet investments are not a choice, but an almost unavoidable spiral with very few options. As a part of the launching of Microsoft, the company will not support earlier versions of Windows (95, 98 and 2000) after the month of July. It does not mean that you cannot use Windows 2000 after the 1<sup>st</sup> of July. But it means e.g. that you cannot expect new gadgets, software and different kinds of hardware to function together with earlier versions of Windows. It is possible e.g. to purchase a printer, but you might have to upgrade to Windows XP to make it function, and in this way a lock-in effect of the customer is obtained, cf. Hax & Wilde (1999).

Another approach to internet-investments regards it primarily as a learning process. It is more important to allow room for experiments with the technology than to settle on one single solution. Correspondingly, attention may be focused on knowledge sharing and exchange or establishing IT and Internet competence in the organisation, which will not necessarily give measurable

results in pounds and pences –and especially not in the short term.

Two main schools of measuring effects have crystallized: financial and non-financial measurements or said in a more popular way: "hard and soft" measurements, cf. Dempsey et al. (1998). At company level, the financial methods include bottom line results for the organisation or department, present value and cost-benefit analyses of projects. At society level, the financial methods comprise effects on the GNP, export/ import, the interest rate and, if any, supply and demand effects.

An alternative financial evaluation method of IT investments is to use the "real options" theory, cf. Li & Johnson (2002). Li & Johnson suggest that different models are used depending on the level of the technological "switching costs" and the competitive situation of the organisation. The real options theory can also be used as a starting point for strategic actions and support the decision-making process relating to evaluation and justification of IT investments (Kim & Sanders 2002).

At company level, the non-financial methods deal with portfolio and "balanced score card" techniques and at society level with more general issues such as qualification of the labour force. Environment, working environment and social responsibility may be focus areas on both company and society levels.

Table 1: Measuring Effects.

	Financial Effects	Non-financial Effects
Company Level	Return on investment (ROI), Net Present value (NPV), Cost-benefit	Portfolio, Balanced Score Card, Environmental, Working Environmental, and Social Responsibility
Society Level	Gross National Product (GNP), Export/Import, Interest Rate, Supply and Demand	Environmental, Working Environmental, and Social Responsibility, Job Content and Quality

In large organisations with several IT-projects running simultaneously, portfolio management of the IT-projects is often necessary (Solomon 2002). In this connection, it may be an advantage to perform cost-benefit analyses of the individual IT-projects/investments to allow management to see where the money has been spent, why it is or is not necessary to maintain projects and which resources are vital to continue the drive. Therefore, portfolio management makes it necessary to establish comparable criteria in cost-benefit analyses.

Regardless of perspective, it is rarely an advantage to disregard the financial perspective. Attention to the operating profit and ROI (return on investment) is crucial,

cf. King (2002).

## 5. Objectives and Principal Elements in CBA

To make a proper cost-benefit analysis (CBA), it is crucial to know the owner of the investment and what objectives the owner, i.e. person, department or private/public organisation, wants to achieve with the IT-investment. A number of studies show that IT-investments are not always based on or part of a strategy, which is why the relevance of cost-benefit analyses might be unclear (Clarke 1995). Even when the objectives are clearly stated, it is paramount to know where and how to achieve and measure the benefits. In other words, it is necessary to have general strategic objectives that can be decomposed into measurable and localised benefits.

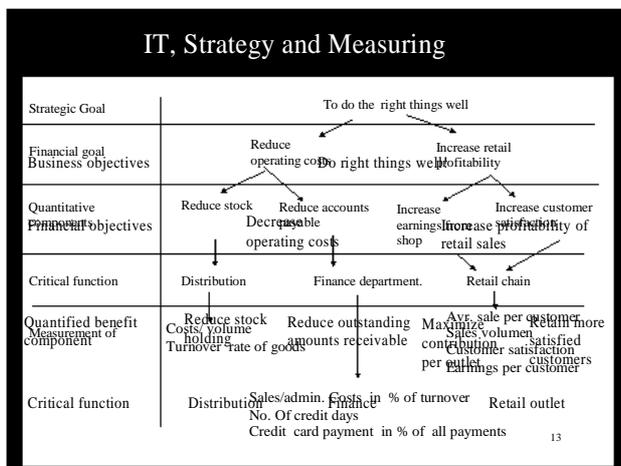


Figure 1: IT, Strategy and Measuring.  
Source: Developed after (Willcocks, Feeny et al. 1997).

CBA's of Internet solutions assume that they have a direct or indirect impact on e.g. the company's operating profit as direct cost saving or indirect cost avoidance measures and that the strength of the impact is expedient and feasible to determine (situation 1). Others believe that the relation between organisation and IT, including derived effects/learning processes, is so complex that it is futile to talk about CBA of IT (situation 2). Others again argue that it only has limited value to focus on the company's CBA of IT in the network society. Instead, we ought to focus on the dependencies – static as dynamic - of which both the technique and the company are part. CBA is hardly the most suitable tool for such purposes (situation 3).

## Fundamental choices before CBA

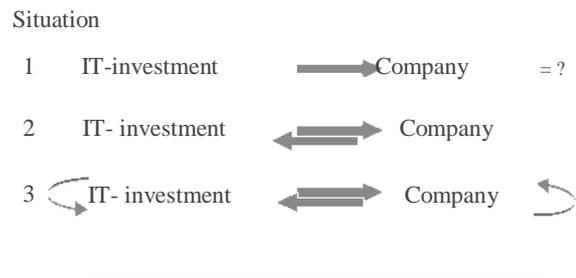


Figure 2: Fundamental Choices Prior to CBA.

### 5.1 CBA Elements

A relevant CBA question to an IT-project is: What does it cost and which benefits do we derive? However, after this question it becomes more difficult. A basic advice is to clarify the conditions on which the CBA is based, including the organisation's general approach to IT-projects and management of IT-projects (Cadel and Yeates 2001).

It makes a big difference whether the approach favours an extension of the ideas in the waterfall model about IT-systems development separating pilot surveys (Bødker, Kensing et al. 2000), implementation and utilisation (Earl 1999) or whether e.g. the phases are regarded as an integrated and repetitive process.

The simple CBA comes in three versions:

- ¾ Economic efficiency model
- ¾ Resource allocation model
- ¾ Alternative costs model

The economic efficiency model focuses on the IT-project's costs (C) and benefits (B). In allocating resources, e.g. between one department's application of an Internet solution and another department's system application, allocation weights are used to ensure that department 2's benefits are larger than department 1's costs (disadvantages) in e.g. presentation of an Internet solution. Finally, the alternative costs can be evaluated, i.e. do department 2's benefits from the Internet solution exceed the reallocated resources in the department and the loss, if any, in department 1 as a result of the Internet solution.

## The Simple CBA

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Economic efficiency:  $\frac{B-C}{(B: \text{benefits}, C: \text{costs})}$

Allocation politics:  $\frac{a_2 B - a_1 C}{(a: \text{allocation weights})}$

Alternative costs:  $a \frac{a_2 B - a_2 R - a_1 L}{(L: \text{loss}, R: \text{re-allocation})}$

Figure 3: The Simple CBA.

Of course, it may be difficult to determine benefits, but some benefits are more difficult to determine than others. The figure below lists a range of factors that can be measured directly such as productivity, production costs, administration costs and IT-expenses. The figure's right side shows effects that are more difficult to measure such as increased control of resources and job satisfaction. Whereas the left side illustrates all the interesting measures or input reflecting such measures, the right side may be seen as variables explaining why some Internet solutions are not appreciated or fail to get support from employees.

Table 2: Measuring Benefits.

Measurable Benefits	Benefits difficult to measure
Increased productivity	More efficient use of production facilities
Lower production costs	Improved resource control
Reduction of employees	Improvement of planning function
Lower IT-expenses	Increased flexibility
Lower third party supplier costs	Punctual and more information
Lower administrative costs	Improved organisational learning
General cost reduction	Increased job satisfaction
	Improved decision making
	Improvement of routines
	Increased user/customer satisfaction
	Improvement of image

A third of the orders are placed with sales representatives at visits, another third via telephone/fax/e-mail, a sixth via physical purchases in shops and a sixth with the suppliers via the Internet.

The administrative costs are estimated to be DKK 80,- per order (ordering, invoice processing, payment). When reordering, the total administrative cost is estimated to be DKK 100,-.

Now, an internet-based purchasing solution is established. It requires an initial investment of DKK 1 million, including training. If all purchasers are going to

have a PDA, it will cost another 3 million.

In the solution, the useful life of the investment is estimated to be 2 years after which the replacement price will be DKK 2 million. If the austerity model without PDA is chosen, the replacement price after 2 years will only be DKK 500,000.

From day one, 300 suppliers are part of the solution, and at the end of the first year another 100 suppliers have joined. At the end of the second year, another 250 have joined. At the beginning of the first year, 40% of all orders are covered by the solution. At the end of the second year, it is estimated that 80% of all order lines are covered. At the end of the second year, it is also estimated that the total decline in faulty orders is 50% among orders placed via the Internet. The increase in the number of digital suppliers and orders including the reduction in faulty orders is a linear and inter-polar process.

The interest level is fixed at 7%.

A government agency wants to introduce self-service via the Internet. The objective is to improve citizen service, make cold hands warm and facilitate analyses of work processes.

The agency is primarily occupied with case administration and has approx. 100 employees. The annual payroll costs are DKK 32.5 million (in total 166,000 working hours). 55 employees are directly engaged in casework (in total 91,300 hours). The total operating budget including payroll costs amounts to DDK 51 million, out of which 18.5 million is allotted to other operations. This amount is not affected by the Internet solution.

Annually, there are 8,000 completed cases (on average 12.5 hours/case), 17,300 inquiries from citizens about cases (on average 15 minutes spent directly) and 7,000 inquiries from citizens (telephone, letter, fax, e-mail) that have nothing to do with concrete/non-completed cases (on average 10 minutes spent directly, 10 minutes follow up).

In addition, there are 2000 annual inquiries from politicians, departments and other bodies (on average 20 minutes spent directly, 30 minutes follow up).

Table 3: Consumption per hour before implementation of IT-solution and after implementation of alternatives A and B.

			Alternative A	Alternative B
Workflow	Sorting and achieving	10.000 h	5.000 h	5.000 h
	Find cases	15.000 h	4.000 h	21.000 h
	Evaluate content	5.000 h	5.000 h	23.000 h
	Meetings	35.000 h	25.000 h	37.000 h
	External meetings	21.207 h	10.000 h	45.000 h
(1)	Total	85.207 h	49.000 h	131.000 h
Inquiries	Handling the case	15 min. x 17.300	5 min. x 10.000 inq.	5 min. x 50.000 inq.

		inq.		
	General inquires	10 min x 7.000 inq.	3 min. x 17.000 inq.	1 min. x 87.000 inq.
	Internal / from politicians	50 min. x 2.000 inq.	15 min. x 1.700 inq.	10 min. x 31.000 inq.
(2)	Total	7.169 h	2.108 h	7.083 h
(3) Other		72.634 h	72.634 h	72.634 h
Total		166.000 h	123.742 h	210.717 h

They have now adopted an Internet solution that involves complete indexation of cases, IT-project management on case, employee, department and management levels and 'open' access to all input, output, content and benchmarks for at least one person other than the relevant caseworker. The initial investment (development and implementation) including training is estimated to DKK 1½ million and adjustment of existing applications will cost another 4 million. The useful life of the solution is estimated to be one year with an annual replacement price of DKK 750,000. The interest level is fixed at 7%.

In alternative A, the number of time-consuming direct inquires about specific cases declines. As a result of the Internet solution, citizens can now find answers to some inquires from the information available at the Internet. There is a small drop in inquiries about the progress of cases from other employees and politicians, but a significant drop in the number of minutes that each inquiry takes. On the other hand, there is a marked increase in general inquiries. However, now they only take 3 minutes compared to 10 minutes previously.

In alternative B, the number of inquiries explodes from all sides: case inquiries increase from 17,300 to 50,000, general inquiries increase from 7,000 to 87,000 and 'internal' inquiries increase from 2,000 to 31,000. A cost benefit analysis is made for alternatives A and B.

## 5.2 The Point is the Result as well as the Process

Partly, examples A and B provide inspiration by showing two interesting cases, and partly they illustrate that efforts to acquire the necessary data often give us the chance to look at the IT-solution in ways that we would not have done without a CBA. We are forced to explicate preconditions and assumptions about IT-investments. We readily admit that often it does not make sense to make a CBA. In several studies at the Department of Informatics, we have continued our research into the elements in CBA that can be measured directly or are difficult to measure. We distinguish between content variables and flow (process variables).

## 5.3 Content and Flow Variables in Determining Benefits

Content variables in a CBA may include capacity, interaction, values and orientation. The capacity variable deals with the quality of information, efficiency and effectiveness. The interaction variable focuses on control and power, including customer relations. Values comprise e.g. stress and legal protection. Finally, orientation relates to how often the Internet solution leads to a more digital decision-making process reducing other communication and decision forms. In a large-scale international study, we have found that the effects are unmistakably positive on the capacity side, but predominantly negative on the value side.



Figure 4: Content Variables.

Through the process variables, we focus on the flow in communication. The four variables in the flow analysis include volume, data integration, diversity and span. We might expect that companies selling via the Internet would score 100% on the variable data integration. But that is not at all the case. Only 25% of the companies selling via the Internet are capable of effecting an automatic integration with the IT-systems in charge of executing orders (delivery, production, etc.). Approx. 14% of the companies have integrated Internet sales with the invoice system (Danmarks Statistik 2002).

Table 4: Process variables (flow)

Variable	Description
Volume	What percentage of the total number of documents is exchanged via this solution?
Integration	What percentage of documents received digitally is forwarded digitally?
Diversity	What percentage of the total number of different types of documents is included in the digital solution?
Span	What percentage of business partners takes part in the digital exchange?

Source: Andersen et al. (2001).

## 6. Managerial Overview of the CBA of Internet Investments

In this paper, we have looked at different approaches to and perspectives on cost-benefit analyses of Internet investments. We have especially focused on distinguishing between financial and non-financial methods and the identification of content and flow variables.

In the paper, we have highlighted a number of recommendations summarised in the table below:

No.	Recommendations
1	Identify the owner of the planned investment
2	Identify investment objectives
3	Choose perspective (additional earning capacity, cost reduction, development of communication/relations and/or learning/knowledge management)
4	Choose method (financial and/or non-financial)
5	Identify content variables in CBA
6	Identify flow variables in CBA
7	Perform the CBA

However, cost-benefit analyses should not stand alone. Often, it is an advantage if organisations look at "Total Value of Ownership" (TVO). TVO consists of three elements, cf. Dempsey et al. (1998). The first step involves a thorough cost-benefit analysis to evaluate the expected increase in value from the investment. Second, sturdy management processes are important to integrate IT and Internet into the normal business planning. And finally, it is important to have some experience in business evaluation to be able to make difficult trade-offs efficiently.

## 7. Conclusions and Future Research

The paper addresses the important issue of cost and benefit evaluation when organisations are considering investing in exploitation of the Internet.

In particular, the paper address different approaches to CBA and suggests that evaluation ought to consider content as well as flow variables

The paper presents two case studies. The first case study is from the private sector and deals with purchasing via the Internet. The second study, which is from the public sector, deals with self-service via the Internet.

Finally, the paper provides an applicable short-list of important activities and decisions in a cost-benefit analysis.

Future research will go into in-depth case studies and comparable studies in order to provide further empirical data. Moreover, the analysis method will be challenged with other bodies of theory in order to provide a robust approach.

## References

- Adler, M.D. & Posner, E.A. (1999). Rethinking Cost-Benefit Analysis. *The Yale Law Journal*. New Haven. November, Volume 109, Issue: 2, pp. 165-247.
- Andersen, K.V. & Juul, N.C. & Larsen, M.H. (2001). Counting Digital Procurement Impacts on Governmental Operations Using the CIVO-VIDS Methodology. In *Proceedings of The European Conference on e-Government (ECEG 2001)*. September 27-28, Trinity College Dublin, Ireland, pp. 5-14.
- Bleichrodt, H. & Quiggin, J. (1999). Life-cycle preferences over consumption and health: When is Cost-Effectiveness Analysis Equivalent to Cost-Benefit Analysis? *Journal of Health Economics*. Vol. 18, Iss. 6, pp. 681-708.
- Bleichrodt, H. & Quiggin, J. (2002). Life-cycle Preferences over Consumption and Health: a Reply to Klose. *Journal of Health Economics*. Volume: 21, Issue: 1, pp. 167-168.
- Bødker, K. & Kensing, F. (2000). *Professionelle IT-forundersøgelser – grundlaget or bæredygtige IT-anvendelser. Hvordan undgås IT-skandaler?* København. Samfundslitteratur.
- Brent, R.J. (1996). *Applied Cost-Benefit Analysis*. Edward Elgar.
- Cadel, J. & Yeates (2001). *Project Management for Information Systems*. London. Prentice Hall. Financial Times Management.
- Clarke, R. (1995). Computer Matching by Government Agencies: The Failure of Cost/Benefit Analysis as a Control Mechanism. *Information Infrastructure & Policy*, 4(1), pp. 29-65.
- Danmarks Statistik (2002). *Danske Virksomheders brug af IT 2001*. København.
- De Haan, J.J. and De Groene, A. (1993). A cost-benefit instrument as a tool to integrate environmental policy into the overall business-policy. Paper presented at the Greening of Industry Conference, Boston MA.
- De Haan, J.J. and Peters, R. (1989). Cost benefit analysis of the introduction of computer aided production technologies, in Ferdows, K. and Karlsson, C., *Management and New Production Systems*, INSEAD, Fontainebleau, pp. 179-200.
- De Haan, J.J. and Terra, N. (1988). *Baten de kosten? Een bedrijfseconomische waardering van arbeidsplaatsverbetering*, NIA, Amsterdam.
- De Haan, J.J. de & Mol, K. van (1999). Soft-investments Appraisal Cost-Benefit Analysis of the Implementation of Work Groups as an example. *International Journal of Operations & Production Management*. Vol. 19, Iss. 1, 38-55.
- Dempsey, J. & Dvorak, R.E. & Holen, E. & Mark, D. &

- Meehan III, W.F. (1998). A Hard and Soft Look at IT Investments. *The McKinsey Quarterly*. Number 1, pp. 127-137.
- Dey, P.K. & Gupta, S.S. (2001). Feasibility Analysis of Cross-Country Petroleum Pipeline Projects: A Quantitative Approach. *Project Management Journal*. Volume: 32, Issue: 4, pp. 50-58.
- Earl, M.J. (1999). *Management Strategies or Information Technology*. Prentice Hall.
- Fischer, R.J. (1994). An Overview of Performance Measurement. *Public Management*. 76, pp. S2-S8.
- Hamilton, S. & Chervany, N. (1981). Evaluating Information systems Effectiveness – Part 1: Comparing Evaluation Approaches. *MIS Quarterly*, September, pp. 55-69.
- Hax, A. & Wilde II, D.L. (1999). A Delta Model: Adaptive Management for a Changing World. *Sloan Management Review*, Vol. 40, No. 2, pp. 11-28.
- Honig, B. & Lampel, J. (2000). Interorganizational Entrepreneurship in a Global Arena. *International Journal of Organizational Analysis*. Volume: 8, Issue: 4, pp. 343-363.
- Journal of Regional Science*, May, Vol. 41, Iss. 2, pp. 277-299.
- Julnes, P. de L. (2000). Decision-making tools for public productivity improvement: A comparison of DEA to cost-benefit and regression analyses. *Journal of Public Budgeting, Accounting & Financial Management*. Winter, Vol. 12, Iss. 4, pp. 625-646.
- Kim, Y.J. & Sanders, G.L. (2002). Strategic Actions in Information Technology Investment based on Real Option Theory. *Decision Support Systems*. Vol. 33(1), May, pp. 1-11.
- King, W.R. (2002). IT Capabilities, Business Processes, and Impact on the Bottom Line. *Information Systems Management*. Vol. 19(2), Spring, pp. 85-87.
- Lee, M. & Cunningham, L.F. (2001). A Cost/Benefit Approach to Understanding Service Loyalty. *The Journal of Services Marketing*. Vol. 15, Iss. 2, pg. 113-133.
- Li, X. & Johnson, J.D. (2002). Evaluate IT Investment Opportunities using Real Options Theory. *Information Resources Management Journal*. Vol. 15(3), July-September, pp. 32-47.
- McDonald, J. (2001). Cost-Benefit Analysis of Local Land Use Allocation Decisions.
- Mishan, E.J. (1971). *Cost Benefit Analysis*, Allen and Unwin, London.
- Ngwenyama, O.K. (1999). Making the Information Systems Outsourcing Decision: A Transaction Cost Approach to Analyzing Outsourcing Decision Problems. *European Journal of Operational Research*. Vol. 115, Iss. 2; pg. 351-367.
- Nolan, T.V & Jarema, K.A. & Austin, J. (1999). An Objective Review of the Journal of Organizational Behavior Management: 1987-1997. *Journal of Organizational Behavior Management*. Volume: 19, Issue: 3, pp. 83-114.
- Noy, E. (1999). There are Profits in Your Management Control Systems. *Managerial Auditing Journal*. Volume: 14, Issue: 7, pp. 363-367.
- Solomon, M. (2002). Project Portfolio Management. *Computerworld*, Framingham, March 18, Vol. 36(12), p. 52.
- Willcocks, L. (edit.) (1994). *Information Management. The Evaluation of Information Systems Investments*. Chapman & Hall, London.
- Willcocks, L.D. & Feeny, et al. (eds.) (1997). *Managing IT as a Strategic Resource*. London. McGraw-Hill.
- Yedla, S. & Parikh, J.K. (2001). Economic Evaluation of a Landfill System with Gas Recovery for Municipal Solid Waste Management: A Case Study. *International Journal of Environment & Pollution*. Volume: 15, Issue: 4, pp. 433-447.

# Study on the Search Cost in the Electronic Market

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## Extended Abstract

The development of IT, especially the emergence of Internet, has influenced the purchasing behaviors of customers in recent years. Many literatures argue that the Internet leads to intense price competition and the market will finally evolve into a frictionless state because the consumers can acquire the product information more and more easily. However, some research results show this is not always true. For example, Lee found that the price of used cars auctioned in the e-market is higher than that of the conventional market in Japan; Bailey did a research on the products, such as books, CD and software in Boston area and indicated that the e-market's price is higher. So in order to explain the influence of information technology on consumers, we build a search model in this paper and use the search theory to analyze it.

Our model inherits some characteristics from some previous search models and discusses an important variable--search cost. The first search model, the Hotelling Model, regarded travel costs as consumers' search costs and pointed out that search cost is a source of monopolization. But it did not take the factor of sellers, which might influence the search cost as well, into account. Although Salop, Bakos, Zettlemeyer, Rajav Lal improved this aspect of Hotelling's model, their definitions of search cost did not differ much from Hotelling's in essence. Different with these models, we bring forward an inventive idea that the search costs are divided into two parts: one is called systematic search cost and the other is nonsystematic search cost. Systematic search cost is the cost of accessing a seller and negotiating the price, which may occur in every purchase, and it is a feature of markets. Both transportation fee and calling fee belong to this part. Generally speaking, buying the products in a conventional market would cost

consumers more systematic search cost than in an e-market. On the other hand, nonsystematic search cost isn't an innate feature of markets and can be controlled by sellers. They can manipulate this part of search costs through many ways like the products' design, marketing, the layout of product-selling homepages and so on. The more the products deviate from the normal, the higher this kind of cost is. And the nonsystematic search cost is optional, which means that consumers may buy a product before knowing its exact utilities.

In this paper, we mainly discuss the equilibrium of oligarch markets. It assumes there are two firms selling the same kind of products in the market. The first one is the leader and the other is the follower. Every consumer is buying at most one item from the two sellers and can return the dissatisfying items with paying the return cost, which is also a feature of market. It is supposed that there is no difference of quality between the products of the two sellers, but there may be some non-quality differences, such as the appearance and the design of the products. Consumers know the prices, the systematic search costs, and the non-systematic search costs. However, they don't know the gross utilities they will derive from the product but know the distribution pattern of the utility. The search pattern of customers could be illustrated in a search tree. In each stage of the search tree, customers can choose an action from the action set according to the expected utility of each one. On the other hand, sellers must make the decisions of the two variables: prices and the nonsystematic search costs. The decision-making process is a two-stage perfect-information game. First, the sellers must seek the price equilibrium under certain combination of nonsystematic search cost. Secondly, after solving the problem of sub-game equilibrium, we can get the nonsystematic search cost equilibrium and it comes the equilibrium for the whole problem.

By simulation, we get the equilibriums of the market for some special cases. And some managerial implications derived from the simulation results are that in a low-return-cost market, the higher systematic search cost, such as the transportation fee and the calling fee, may cause the followers of the market gain less. If this kind of search cost is high, people are relatively unwilling to search and buy the products of the less famous producer, that is, the follower's products. And even after buying the follower's products, because the return cost is low, many consumers would choose to return the dissatisfying items. So in a low-return-cost market, the higher systematic search cost is a disadvantage to the follower. It is recommended that the followers may invest in information technology, e.g. the Internet to make search easier and lower the systematic search cost. By realizing the information technology first, the follower can put the leader into a disadvantageous circumstance. Therefore, the leaders, on the other hand, should also

utilize the technology to consolidate their power in the market as well. And in a high-return-cost market, the higher systematic search cost is also a disadvantage to the follower. The application of information technology can also benefit the follower and the leader. In addition, different from the low-return-cost market, our results show that in the high-return-cost market followers might choose to differentiate themselves to increase the non-systematic search cost. Because of the high nonsystematic search cost, the consumers would buy the products directly without knowing the exact utility of the product. Moreover, the high return cost would keep the consumers from returning the dissatisfying products. In this way, the followers lock the consumers who might originally not buy the products after knowing the exact utilities of them. Even if the leaders build the electronic transaction market firstly, the followers can also differentiate themselves to set a defense state against the competitors.

# An Intelligent Interface Integrated Services Environment for Electronic Commerce

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## Abstract

This paper proposes an intelligent interface integrated services environment for electronic commerce. It contains four main modules, i.e., dialog manager, EC transaction ontology, information collector, and data analyzer. The dialog manager manages the transaction history of the user to collect the user-specific information. It also provides different helping functions for the user. The EC transaction ontology stores the business type of electronic commerce in the system. It classifies the business process into eight categories, i.e., transaction type, ordering pattern, merchandise type, logistic type, customer category, transport vehicle, delivery type, and service type. It also provides the relations and constraints between different business steps. The information collector instantiates and dispatches different information agents to extract, filter, and synthesize relevant transaction data from different data sources timely. The data analyzer is the main component of the system. It instructs the dialog manager to provide proper helping functions for the different users. It then uses the user model to classify the knowledge and skill level of a user. It also predicts the goal of the user by using case-based reasoning and fuzzy Petri-Net to recommend the user with the best transaction plan and browsing behavior. Finally, it monitors the quality of service that the system provided for the user. This environment not only provides an integrated human-machine interface but also manages the business information thoroughly for the users.

## 1. Introduction

The pervasive connectivity of the Internet provides the best mediation for a company to reduce the cost of products and establish closer relationship with customers. These companies usually incorporate the selling and marketing policy to provide interactive, friendly, and reliable services for the user. Electronic commerce (EC) should become the critical successful factor to compete with others in the modern network marketing [1][3][6][13][15]. The supply chain management (SCM) and customer relationship management (CRM) play important roles in EC. The SCM provides the efficient management method to deliver products from the supplier to the customer quickly. It incorporates the supply chain resources including ordering, logistics, manufacture, and

distribution to response any change of the market timely. The CRM provides an interactive, kind, and customer-made service to understand and serve their users. It incorporates the personalized service for different users to achieve the most loyalty and the maximum benefits for the company perfectly.

Many industries complete business transactions through the traditional or semi-automatic procedures, i.e., electronic data interchange, to buy or sell goods. They usually use some traditional or special communication equipments to exchange transaction information. These data exchange process may cause some limitations. First, the data contained in the business process may not be able to combine into an information chunk completely. It may cause some process delay or mistake, e.g., ordering and dispatching, if it only works done by hand or separate the whole transaction process into many pieces steps. Second, both the buyer and seller may produce misunderstandings or lose the chance to make competitive advantages if they cannot obtain complete, sufficient, and transparent information just in time. Third, they didn't provide a friendly and customize human-machine interface for the users in the traditional transaction procedure. It may obstruct the transaction process for different kinds of users. Finally, they didn't provide any systematic and suitable assistant and helping for the user with different experiences to complete the business transaction properly.

Many systems have been proposed to solve the above shortcomings. They try to use EC contained in the above to automat the business process. Seldom of them provide an integrated service environment for the users. They don't provide a transparent interface to integrate the data that located in heterogeneous data sources and distributed in many different sites. They also cannot provide an anytime service to present the business information just in time. They usually ignore the privilege of the user to understand and utilize the information in the process of EC. Moreover, many systems only provide a stereotyped interface for the user to yield the system. They don't consider the requirements and the working environment for the user with different experiences and proficiency.

This paper proposes an intelligent interface integrated services environment for electronic commerce. It contains four main modules, i.e., dialog manager, EC transaction ontology, information collector, and data



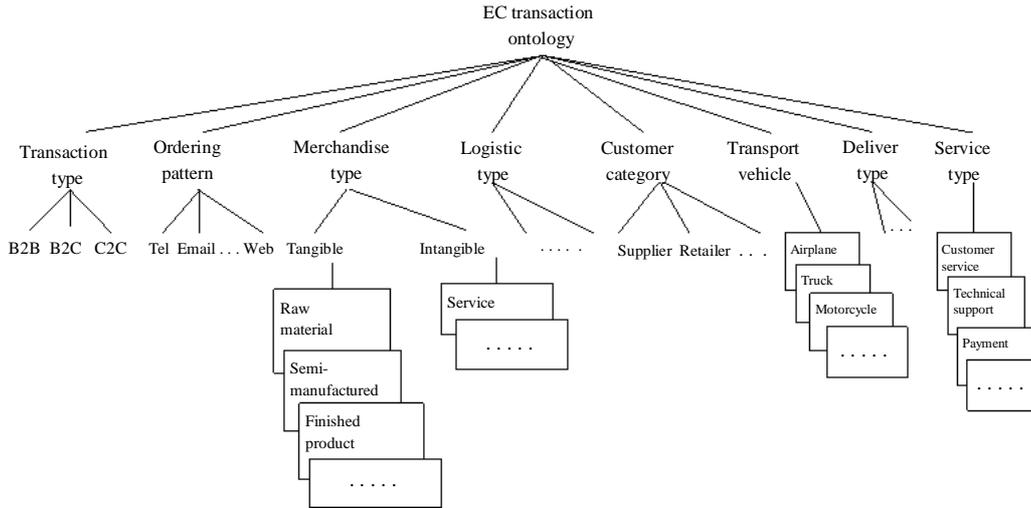


Fig. 2 EC transaction ontology

## 5. Information Collector

Information collector dispatches different information agents to retrieve related transaction data. The information agent is responsible to retrieve data from different data sources or heterogeneous database. It was generated from the agent pattern library that contains different agent components to do different tasks. The information collector instantiates and composites these patterns to construct different information agents. It retrieves, filters, synthesizes, and sends the most reliable data that the agent collected so far to the data analyzer. Each agent plays the role of intelligent anytime agent by recording the retrieved data in the information model. The information model contains the characteristics and the up-to-date data of the information sources. Note that the execution of the pattern library was implemented by Sun's Java remote invocation (RMI) [14]. Fig. 3 shows the pattern of Connect\_data\_server in the pattern library.

Pattern name: Connect\_data\_server

Pattern task: Data server connection

Receiving: Data server location, database type

Production: Connection status

Context: N/A

Executor:

```
import java.rmi.*;
import java.sql.util.Vector;
public interface Connect_data_server extends Remote
{ void accept(Agent agent) throws RemoteException;
  Vector Connect() throws RemoteException, SQLException;
}
public interface Agent extends java.io.Serializable
```

```
{ void run();
}
```

Fig. 3 The Connect\_data\_server pattern

## 6. Data analyzer

The data analyzer performs four tasks, namely, user modeling, plan prediction, user assistant, and quality of service monitoring. The user modeling classifies the user into different skill and knowledge level. The user profile contains the user-related information, e.g., habit, preference, and consumer behavior. The data analyzer uses the above information to classify the users. It preliminarily uses fuzzy ART neural model [2] to classify the users into different groups (Fig. 4). Each group contains the users with same characteristics. It then discriminates the knowledge and skill level of each group of the users. The former evaluates the accuracy, usefulness, direction, and reliability of the user's into five levels, namely, expert, senior, junior, novice, and amateur [8]. The latter measures the correctness, precision, dependency, and effectiveness. The correctness,  $U$ , measures the correct steps to do business process.

$$U = 1 - \sum_{i=1}^n e_i \quad (1)$$

where  $e_i$  represents illegal or wrong steps in the business process and  $e_i \in [0,1]$ . The precision,  $P$ , represents the average number of operations to complete the business transaction.

$$P = \frac{\sum_{i=1}^n t_i}{n} \quad (2)$$

where  $t_i$  is the number of operation to complete the  $i^{\text{th}}$

transaction and  $n$  is number of transaction. The dependency,  $D$ , represents the dependency between the business steps.

$$D = \frac{\sum_{i=1}^{n-1} I_i \cap I_{i+1}}{n-1} \quad (3)$$

where  $I_i$  is the  $i^{\text{th}}$  step of the business process and  $n$  is the total number of step in the business process. The effectiveness,  $E$ , measures the efficiency of the user to complete the transaction.

$$E = \frac{\sum_{i=1}^n w_i}{n} \quad (4)$$

where  $w_i$  represents the time to finish the task and  $n$  is the number of completed task. The dialog manager may provide different helping functions, interaction modes and graphical user interface for each group of users with different knowledge and skill proficiency correspondingly [8].

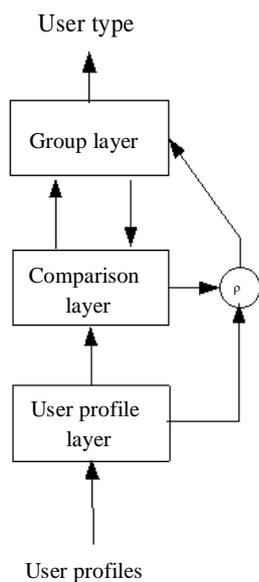


Fig. 4 Fuzzy ART for user classification

The plan prediction predicts the transaction plan of the user by using case-based reasoning (CBR) [4][8][9] and fuzzy Petri-Net [5]. The former technique uses the past business history of the user to find the most similar plan. The latter technique uses the similar business plan and the user profile to predict the possible browsing behavior.

The user assistant provides a robust assistant for the user to complete the business transaction with the help of EC transaction ontology. First, it checks the completeness and rationality of the transaction data. It then guides the user to input relevant data in the

transaction steps. It also recommends the appropriate actions, steps, and browsing behavior for the user to complete the transaction. The quality of service monitoring measures the service quality (SQ) of the information sources.

$$SQ = F(A, C, R, T) = A * W_a + C * W_c + R * W_r + T * W_t \quad (5)$$

where  $A$ ,  $C$ ,  $R$ , and  $T$  represent the availability, consistency, reliability, and timelessness of the information source, respectively.  $W_a$ ,  $W_c$ ,  $W_r$ , and  $W_t$  are the respective weights. Fig. 5 shows the fuzzy levels of the SQ.

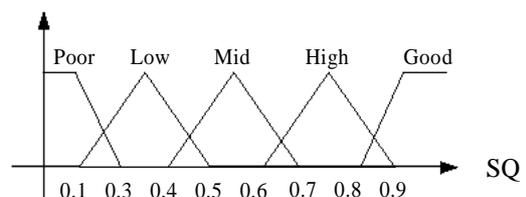


Fig. 5 Fuzzy levels of the service quality

## 7. Conclusions

We have proposed an intelligent interface integrated services environment for electronic commerce to provide an integrated human-machine interface and business information management. The environment contains four main modules, namely, dialog manager, EC transaction ontology, information collector, and data analyzer. The dialog manager manages the transaction history and supports different styles of interaction patterns and helping functions for the user according to its experiences and knowledge level in business transaction. The EC transaction ontology provides eight categories of business process to assist the data analyzer handling the transaction information. The information collector instantiates and dispatches different anytime information agents to extract, filter, and synthesize relevant transaction data from different data source timely. The data analyzer is defined as the major component to instruct the dialog manager; discriminate the skill and knowledge level of the user; predict the goal of the user; and monitor the quality of service.

In summary, the proposed intelligent interface integrated services environment exhibits the following interesting features. First, it differentiates a business user into different levels according to the skill and knowledge level of the users. It then provides an adaptive interface to complete business transaction process for the user. Second, it identifies the content of the EC transaction and depicts them into the EC transaction ontology clearly. The ontology may provide great helping for the users in intelligent interface. Third, it uses the agent pattern library to instantiate and dispatch appropriate anytime information agents to collect the

transaction data. These agents can be endowed with different tasks in the information collection process within the divergence data sources. Fourth, the user modeling separates the user classification into two phases. It discriminates the users into different groups by adopting the fuzzy ART neural networks. It then uses the fuzzy measurement to evaluate the levels of the user according to its skill and knowledge level. Finally, it uses CBR and fuzzy Petri-Net to predict the possible business plan and browsing behavior.

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### References

1. Akkermans, H. "Intelligent E-Business: From Technology to Value," *IEEE Intelligent Systems*, 2001, 16(4), 8-10.
2. Carpenter, G.A., Grossberg, S. & Rosen, D.B. "Fuzzy ART: Fast Stable Learning and Categorization of Analog Patterns by an Adaptive Resonance System," *Neural Networks*, 1991, 4(6), 759-771.
3. Casati, F., Georgakopoulos, D. & Shan, M.C. *Technologies for E-Services*, Springer, Heidelberg, Berlin, 2001.
4. Chan, C.W., Chen, L.L. & Liqiang, G. "Knowledge Engineering for an Intelligent Case-Based System for Help Desk Operations," *Expert Systems with Applications*, 2000, 18(2), 125-32.
5. Chen, S.M., Ke, J.S. & Chang, J.F. "Knowledge Representation Using Fuzzy Petri Nets," *IEEE Transactions on Knowledge and Data Engineering*, 1990, 2(3), 311-319.
6. Daoud, F. "Electronic Commerce Infrastructure," *IEEE Potentials*, 2000, 19(1), 30-33.
7. Guha R. V. & Lenat, D.B. "CYC: A Mid-Term Report," *AI Magazine*, 1991, 11(3), pp. 32-59.
8. Hsu, C.C. *A Hybrid Case-Based Reasoning Architecture and Its Application*, Ph. D. Dissertation of National Taiwan University of Science and Technology, Taiwan, 2000.
9. Kolodner, J. *Case-Based Reasoning*, Morgan Kaufmann, San Mateo, CA., 1993.
10. Lassila, O., Harmelen, F.V., Horrocks, I., Hendler, J. & McGuinness, D. L. "The Semantic Web and Its Languages," *IEEE Intelligent Systems*, 2000, 15(6), 67-73.
11. Noy N. F. & Hafner, C. D. "The State of the Art in Ontology Design: A Survey and Comparative Review," *AI Magazine*, 1997, 18(3), 53-74.
12. Omelayenko, B. "Preliminary Ontology Modeling for B2B Content Integration," *Proc. the 12th International Workshop on Database and Expert Systems Applications*, 2001, 7-13.
13. Ravi K. & Whinston, A. B. *Electronic Commerce - A Manager's Guide*, Addison-Wesley, 1997.
14. Sunsoft, *Java Remote Method Invocation-Distributed Computing for Java*, Sunsoft white paper 1997. Available at <http://www.javasoft.com/features/1997/nov/rmi.html/>.
15. Yanger, R. R. "Fuzzy Methods in E-Commerce," *Proc. International Conference of the North American Fuzzy Information Processing Society*, 1999, 5-11.

# The Optimal Ordering Periods for Internet Shopping under Time Dependent Consumer Demand

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## Abstract

This study attempts to determine the optimal goods ordering periods for internet stores by considering time-dependent consumer demands and close demand-supply interactions. In order to capture dynamic and time-sensitive consumers, the entire study period is divided into a number of ordering periods with various duration. In the demand side, the study formulates a consumer utility function to construct a binary logit model, which determines consumers' choice probabilities between internet shopping and conventional in-store shopping. The expected choice probability of choosing internet shopping is aggregated by a transformation probability density function of individual income based on the logit model. Then, the study further aggregates individual consumer choice probability to estimate the total demand for internet stores by considering variations in access time to retail stores, and delay time of receiving ordered goods. In the supply side, the study formulates transportation costs considering extra labor cost due to 24 hours business hours of internet stores, and constructs inventory costs reflecting the relationship between the batch ordering of goods, which are made by internet store operators to their suppliers and continuous ordering of goods, which are made by their consumers. Finally, a case study and sensitivity analysis are provided by R-company in Taiwan to illustrate the application of the models. The results show how the operators of internet stores should determine the number and duration of ordering periods in response to time-dependent consumer demand, thereby maximizing their profits.

Keywords: Internet shopping, Time-dependent consumer demand, Transportation cost, Inventory cost

## 1. Introduction

Electronic Data Interchange (EDI) and related technologies are making it less expensive to transmit demand information to suppliers. Besides, information flows-based internet shopping has significantly improved consumer service performances by reducing the order processing time and offering goods delivery information such as when the ordered goods will be delivered to consumers. Since the real time demand is known via internet, the inventory costs will be lower by ordering goods from wholesalers or manufactures fewer quantity but more times according to the demand pattern and shipping them directly to consumers. However, high ordering frequency and small order quantity of consumers' internet shopping behavior makes it more expensive to deliver ordered goods to individual consumer [18]. Due to economies of scale, it is cheaper to transport larger amounts per shipment. However, it will also result in higher delay time of receiving ordered goods, consequently, consumers' intention to shopping via internet is sinking lower. This involves a trade-off between the demands of internet stores and logistics costs. Therefore, service strategies must achieve not only the goals of making logistics costs low but also satisfying consumer needs. One of the crucial factors to determine an optimal service strategy is consumer demand for that goods. The assumption of a constant demand is seriously questioned in recent times, since in reality; the demand is generally varied with time. For instance, the peak demand for food products is likely to occur at lunchtime. Therefore, in this study, we explore how to determine the optimal number of ordering periods for internet stores by taking time-dependent consumer demand and demand-supply interactions into account.

The issues regarding internet shopping have been extensively investigated in many studies (e.g., [19, 22, 23]). [4] stated that the home-shopping system eliminated drive time and checkout time, and allowed shoppers to access to distant stores. On the other hand,

one of those disadvantages might be waiting times for ordered goods [28]. Past studies about consumers' shopping mode choices between internet shopping and store shopping focused largely on assessing the benefits and problems of internet shoppers or evaluating factors influencing consumers' intention to adopt internet shopping using collected data (e.g., [11,22]). Others discussed the demographic and psycho-graphic characteristics of internet shoppers in accordance with surveys on local shoppers (e. g., [12, 26, 27]). [17] proposed a network equilibrium framework for analyzing consumers' selection of internet shopping versus store shopping, and assumed consumers to be multicriteria decision makers. In the supply side, [18] concluded the major problem of electronic commerce is that there is more frequent orders with smaller order quantities, thereby resulting in high transportation costs. Hence, [16] designed an optimal mix strategy of drop shipping and in house inventory for e-retailers and identified the optimal solution to the model under uniform, exponential, and normal demand distributions. In another line of research, the physical distribution problems have been extensively investigated in many studies (e.g., [5-10]) but most of studies assumed inelastic demand and ignoring time-dependent consumer demand. Moreover, little has been done to exam the impact of time-dependent demand and 24 business hours of internet shopping on logistics cost.

The internet stores in this study are assumed to operate as retailers who order a batch of goods from wholesalers or manufactures and cooperate with the third party forwarders. In order to capture dynamic and time-sensitive consumer demands, the entire study period is divided into a number of ordering periods. The study area is also divided into a variety of zones with different retail store densities to reflect various spatial competitions between internet stores and retail stores. In the demand side, the study formulates a consumer utility function considering factors such as goods price, delay time of receiving ordered goods, access time to retail stores and individual income, and then constructs a binary logit model, which determines consumers' choice probabilities for internet and conventional shopping modes. Delay time of receiving ordered goods is determined herein as time span between consumers' goods ordering time and goods receiving time, and depends on the goods delivery cycles accommodating lead time for processing and handling. The expected choice probability of choosing internet shopping is aggregated by a transformation probability density function of individual income based on the logit model. Then, the study further aggregates individual consumer choice probability to estimate the total demand for internet stores by taking into account variations in access time to retail stores, and delay time of receiving ordered goods across different ordering periods. Variations in access time to retail stores mainly result from different spatial densities and opening hours of retail stores across different zones and different ordering periods; while delay time of receiving ordered goods varies with the change in internet store operator's goods

delivering cycles, which in turns depend on consumers' demands during each goods ordering period.

Furthermore, in the supply side, the study formulates transportation costs considering extra labor cost due to 24 hours business hours of internet stores, and constructs inventory costs reflecting the relationship between the batch ordering of goods, which are made by internet store operators to their suppliers and continuous ordering of goods, which are made by their consumers. Logistics cost functions for each ordering period are formulated by analytical approach. Then, integrating with the consumer demand model above, a nonlinear mathematical programming model is further formulated to solve the optimal number of ordering periods during the study period as well as the delivery cycles in each ordering period by maximizing the internet store profit subject to the demand-supply interaction.

The remainder of this paper is organized as follows. In section 2 we will formulate the choice model of teleshopping and aggregate consumer demand for goods of each ordering period. Nonlinear programming problems are formulated in Section 3 to determine the optimal number and pattern of ordering periods by maximizing profits subject to the demand-supply equality. In Section 4, numerical experiments are performed to illustrate the effect of the optimal solution to changes in parameters. Finally, Sect. 5 summarizes the study and presents the conclusion.

## 2 Consumer demands for internet stores

Three important groups of factors affecting the shopping behavior are characteristics of goods, the attributes of different shopping modes, and the characteristics of consumers [24]. Generally, goods that need detail examination before purchase are considered less appropriate for internet markets [14]. Thus, goods discussed here are those appropriate for internet markets. In order to capture the dynamic and time-sensitive consumer demand, the study formulates models of consumer choice probability. In the model, we address issues such as differences in consumers' socioeconomic characteristics, temporal variations in consumers' goods ordering time and spatial variation in consumer locations and differentiate competitions between internet stores and retail stores in urban and non-urban areas.

### 2.1 Individual characteristics

Let  $U_k(t, j)$  represent the total utility of a consumer who orders good at time  $t$  zone  $j$  via shopping mode  $k$ . Furthermore,  $U_k(t, j) = V_k(t, j) + e_k$ , where  $V_k(t, j)$  is the deterministic component;  $e_k$  is a random utility component, which represents the unobservable or immeasurable factors of  $U_k(t, j)$ . Suppose that all  $e_k$  are independent and identically Gumbel distributed, the choice probability of choosing shopping mode  $k$  can be estimated by the binary logit model [3] as

$$P_{TS}(t, j) = \frac{e^{U_{TS}(t, j)}}{e^{U_{TS}(t, j)} + e^{U_R(t, j)}} = \frac{e^{U_{TS}(t, j) - U_R(t, j)}}{1 + e^{U_{TS}(t, j) - U_R(t, j)}}, \text{ where}$$

subscripts TS and R denote internet store shopping and retail store shopping, respectively. The difference in the utility value of consumer shopping via internet stores and retail stores determines the choice probability of choosing internet shopping, which can be rewritten as

$$P_{TS}(t, j) = \frac{e^{v(t, j)}}{1 + e^{v(t, j)}} \quad (1)$$

where  $v(t, j)$  denotes the difference in the utility values of consumer shopping via internet stores and retail stores.

The utility function  $v(t, j)$  discussed here has the following specification:

$$v(t, j) = b_0 + b_1 \frac{P_{TS}}{I} + b_2 t_{TS,t} - b_1 \frac{P_R}{I} - b_3 t_{t,R,j} \quad (2)$$

where  $P_{TS}$  and  $P_R$  denote the price levels of goods via internet shopping and retail shopping, respectively;  $t_{TS,t}$  is the delay time of receiving ordered goods when consumers order goods via internet shopping at time  $t$  and  $t_{t,R,j}$  denotes the access time when consumers purchase goods via retail stores in zone  $j$  at time  $t$ ;

$I$  represents the consumers' income;  $b_1, b_2, b_3$  are parameters; and  $b_0$  reflects consumers' relative preference for internet shopping. The average value of time for delay time of receiving ordered goods,  $VOT$ , can then be estimated by Eq. (2). That is,

$VOT = \frac{\int v(t, j) f_I(I) dI}{\int v(t, j) f_I(I) dI} = I \frac{b_2}{b_1}$ , which increases with consumers' income  $I$ .

Assume that individual consumers with different personal income are served by the same supply condition, then the expected choice probability of choosing internet shopping for all consumers can be further estimated by aggregating individual consumer's choice based on the binary logit model and income distribution. The generalized exponential family of distributions may be used to describe income distribution [2]. Herein, we assume personal income  $I$  to be distributed with a normal distribution with a mean of  $m$  and standard deviation of  $s$ . The probability distribution function

(pdf) of  $I$  is  $f_I(I) = \frac{1}{\sqrt{2\pi}s} e^{-\frac{1}{2}(\frac{I-m}{s})^2}$ . From Eq.

(2), other thing being equal,  $v(t, j)$  is a function of  $I$ , so the pdf of  $v(t, j)$  can be expressed by a transformation of pdf of  $I$ . Then, the pdf of  $v(t, j)$ ,  $f_{v(t, j)}(v(t, j))$  can be written as:

$$f_{v(t, j)}(v(t, j)) = f_I \left( \frac{b_1(P_R - P_{TS})}{b_0 + b_2 t_{TS,t} - b_3 t_{t,R,j} - v(t, j)} \right) \left| \frac{b_1(P_R - P_{TS})}{(b_0 + b_2 t_{TS,t} - b_3 t_{t,R,j} - v(t, j))^2} \right| \quad (3)$$

Consequently, taking the expected value of choice probability of choosing internet shopping gives the following expression for the expected choice probability

$$E[P_{TS}(t, j)] = \int_0^1 P_{TS}(t, j) f(P_{TS}(t, j)) dP_{TS}(t, j) \quad (4)$$

The difference in utility values between internet shopping and conventional shopping determines the probability of choosing internet shopping,  $P_{TS}(t, j)$ , in Eq. (1); in other words,  $P_{TS}(t, j)$  is a random variable transformed by  $v(t, j)$ . Hence, the pdf of  $P_{TS}(t, j)$  is shown as

$$f(P_{TS}(t, j)) = f_V \left( V = \ln \frac{P_{TS}(t, j)}{1 - P_{TS}(t, j)} \right) \left| \frac{1}{P_{TS}(t, j)(1 - P_{TS}(t, j))} \right| \quad (5)$$

Substituting Eq. (5) for  $f(P_{TS}(t, j))$  in Eq. (4), then Eq. (4) can be rewritten as

$$\begin{aligned} E[P_{TS}(t, j)] &= \int_0^1 P_{TS}(t, j) \partial f(P_{TS}(t, j)) dP_{TS}(t, j) \\ &= \int_0^1 P_{TS}(t, j) \partial f_V \left( \ln \frac{P_{TS}(t, j)}{1 - P_{TS}(t, j)} \right) dv(t, j) \\ &= \int_0^{\bar{N}} \frac{e^{b_0 + b_1 \frac{P_{TS} - P_R}{I} + b_2 t_{TS,t} - b_3 t_{t,R,j}}}{1 + e^{b_0 + b_1 \frac{P_{TS} - P_R}{I} + b_2 t_{TS,t} - b_3 t_{t,R,j}}} dI \\ &= \int_0^{\bar{N}} \frac{e^{b_0 + b_1 \frac{P_{TS} - P_R}{I} + b_2 t_{TS,t} - b_3 t_{t,R,j}}}{1 + e^{b_0 + b_1 \frac{P_{TS} - P_R}{I} + b_2 t_{TS,t} - b_3 t_{t,R,j}}} \frac{e^{-\frac{(I-m)^2}{2s^2}}}{\sqrt{2\pi}s} dI \quad (6) \end{aligned}$$

## 2.2 Variations in consumer goods ordering time and locations

The impacts of consumers' goods ordering time on their choice probabilities are further analyzed. The delay time of receiving ordered goods is defined as time span between consumers' goods ordering time and goods receiving time, and is shown in Eq. (2) and past studies as an important factor affecting the probability of choosing internet shopping. Once ordering periods are set, the closer the goods ordering time occurs to the deadline of the ordering period, the shorter the time span between consumers' goods ordering time and goods receiving time is, and vice versa. Moreover, long access time to retail stores or delay time of receiving ordered good arises when the number of retail stores is few in sparse areas or consumer goods ordering time happened to be not at business hours. Therefore, it is important to understand how the goods ordering time, which is associated with the delay time of receiving ordered goods and access time to retail stores, affects the utility functions and choice probabilities.

Herein, suppose the entire study period is divided into  $S$  continuous ordering periods, and  $T_i = (t_{i,0}, t_{i,m})$ ,  $i=1, 2, \dots, S$ , is the duration of ordering period  $i$ , where  $t_{i,0}$  denotes start time and



goods, which have been: (1) consumed by consumers, (2) delivered, and (3) ordered by the internet store operator to suppliers. The shaded area in the figure represents the number of “item-hours” for items held by the internet store. Moreover, denote  $t_{i,0}$  as time when the internet store operator orders batch  $O$  and  $Q_{i,0}$  as the number of items ordered in batch  $O$ .

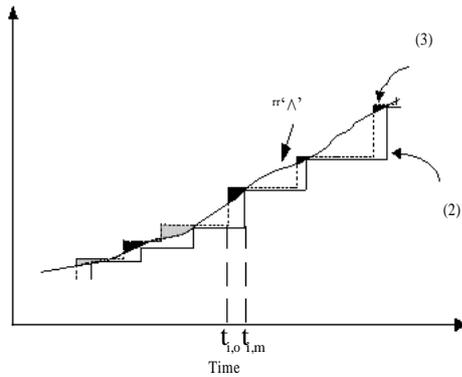


Fig. 1. Inventory cost profile

Inventory cost per item of goods per unit time can be estimated by purchasing cost per item,  $p$  and inventory carrying rate,  $w$ . Therefore, the total inventory cost of ordering period  $i$  resulting from the difference between operator's batch ordering time and consumers' goods ordering time is  $IC_i = pw [Q_{i,r} (t_{i,m} - t_{i,r}) - \int_{t_{i,r}}^{t_{i,m}} q_t]$

And, average inventory cost per item of ordering period  $i$  can be obtained by dividing  $IC_i$  by the total consumer demand of that period, that is  $AIC_i = \frac{1}{Q_i} pw [Q_{i,r} (t_{i,m} - t_{i,r}) - \int_{t_{i,r}}^{t_{i,m}} q_t]$ . Moreover,

average inventory cost per item of the entire study period is

$$AIC = \frac{1}{S} \sum_{i=1}^s AIC_i = \frac{1}{S} \sum_{i=1}^s \frac{1}{Q_i} pw [Q_{i,r} (t_{i,m} - t_{i,r}) - \int_{t_{i,r}}^{t_{i,m}} q_t]$$

Consequently, the average logistics cost per item of the entire study period can be expressed as the sum of average transportation cost per item and average inventory cost per item, that is

$$ALC = ATC + AIC = \# \frac{1}{S} \sum_{i=1}^s \frac{1}{Q_i} (c \partial y_{t_{i,m}} + pw [Q_{i,0} (t_{i,m} - t_{i,0}) - \int_{t_{i,0}}^{t_{i,m}} q_t]) \quad (11)$$

### 3.2 Formulation of the optimal problem

The profit during the entire study period can be computed by the price level per item sold at internet stores,  $p_{TR}$ , purchasing cost per item,  $p$ , average logistics cost per item,  $ALC$  and total consumer demands for items sold at internet stores over the entire

study period,  $\sum_{i=1}^s Q_i$ , such as

$$t = (p_{TR} - p - ALC) \sum_{i=1}^s Q_i \quad (12)$$

where  $t$  represents the total profit of the internet store over the study period. A non-linear programming problem is formulated herein to determine the optimal number and duration of ordering periods by maximizing the operator's total profits subject to demand-supply equality. From eqs. (6), (8), (11) and discussions so far, the nonlinear programming problem is formulated as follows:

$$\text{Max } t = (p_{TR} - p - ALC) \sum_{i=1}^s Q_i \quad (13a)$$

st.

$$ALC = ATC + AIC$$

$$= \# \frac{1}{S} \sum_{i=1}^s \frac{1}{Q_i} (c \partial y_{t_{i,m}} + pw [Q_{i,0} (t_{i,m} - t_{i,0}) - \int_{t_{i,r}}^{t_{i,m}} q_t]) \quad (13b)$$

$$Q_i = \int_{t=t_{i,0}}^{t_{i,m}} q_t^{TS} = \int_{t=t_{i,0}}^{t_{i,m}} \int_{j=1}^n q_{t,j} E[P_{TS}(t, j)] \quad (13c)$$

$$E[P_{TS}(t, j)] =$$

$$= \int_0^{\infty} \frac{e^{-b_0 + b_1 \frac{P_{TS} - P_R}{I} + b_2 t_{TS,i} - b_3 t_{R,j}}}{1 + e^{-b_0 + b_1 \frac{P_{TS} - P_R}{I} + b_2 t_{TS,i} - b_3 t_{R,j}}} \frac{e^{-\frac{(I-m)^2}{2s}}}{\sqrt{2\pi s}} dl \quad (13d)$$

$$\sum_{i=1}^s (t_{i,m} - t_{i,0}) = T \quad (13e)$$

$$i = 1, 2, \dots, s$$

Eq. (13a) is the objective function that maximizes the total profit of the internet store operator over the entire study period. Eq. (13b) defines the average logistics cost per item as described. Eq. (13c) represents the total consumer demand for items sold at the internet store during ordering period  $i$ . Eq. (13d) expresses the expected choice probability for items sold at the internet store. Eq. (13e) restricts that the summation of the duration of all ordering periods must be equal to the entire study period.

### 4. Numerical example and sensitivity analysis

A case study is presented as follows to demonstrate the application of the proposed model based on available data from R-company in Taiwan. To simplify the study,

we merely selected 6 cities from all cities currently served by R-company as our study zones, and assumed one operating day, i.e., 24 hours, as the study period and each unit hour as our study unit-time. Base values for parameters in the utility function, logistics cost function and study zones are either calibrated using stated preference survey or estimated from real data and are shown in Table 1, 2 and 3, respectively. The multipliers reflecting extra cost during different ordering periods,  $y_{t,m}$  are 2 during AM 0:00~9:00, and 1 during other regular hours. Fig. 2 depicts the time-dependent demands for items from consumers in Taipei City, and Fig. 3 represents the total time-dependent demands for items from consumers over the whole study area. The model is programmed using Visual C++, and the results are summarized in Table 4 and Figs. 4-8.

Table 1. The initial values of base demand parameters

Parameter	Initial Value
m	353.4 NT \$/hr
s	199.2 NT \$/hr
$b_0$	2.5
$b_1$	-0.06
$b_2$	-0.018
$b_3$	0.095
V	25 Km/hr

Table 2. The initial values of base supply parameters

Parameter	Initial Value
PTS	NT \$1050
p	NT \$850
PR	NT \$1280
g	NT \$100
c	NT \$850
Tt	0.5 hr

Table 3. The related data about study zones

Zone, j	Area ( $A_j$ km <sup>2</sup> )	Numbers of retail stores, $n_{t,j}$			
		9:00~11:00	11:00~22:00	22:00~23:00	23:00~9:00
Taipei city	271.80	83	105	76	6
Taipei county	2185.56	37	97	43	3
Ilan county	2137.46	11	15	7	1
Taoyuan county	1220.95	48	68	35	2
Hsinchu county	1427.59	17	20	9	1
Hsinchu City	104.10	31	34	17	2

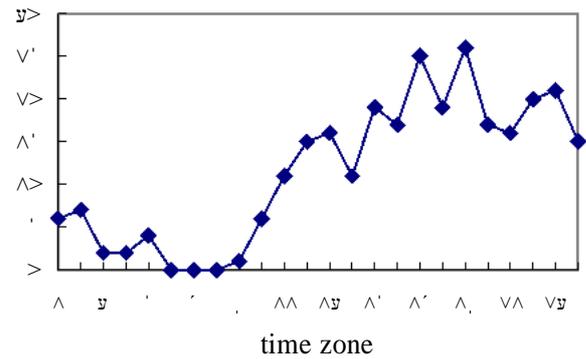


Fig. 2 Time-dependent demands for items from consumers in Taipei City

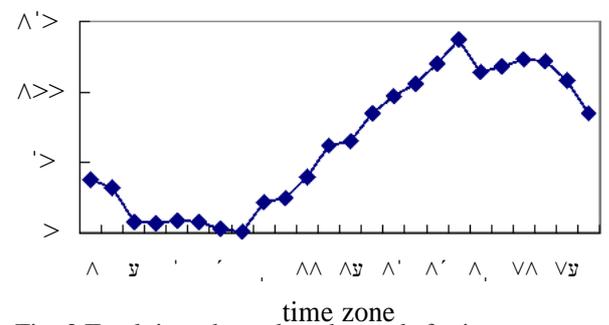


Fig. 3 Total time-dependent demands for items from consumers over the whole study area

Table 4. Results and the optimal objective function value

Optimal number of ordering periods>	6	
Consumer demand of internet stores (item/day)>	1403	
Average logistics cost per item (NT dollars)	104.967	
Objective function value (Profit, NT dollars)>	133331	
Ordering period>	23:00~3:00	3:00~13:00
	13:00~16:00	16:00~18:00
	18:00~21:00	21:00~23:00

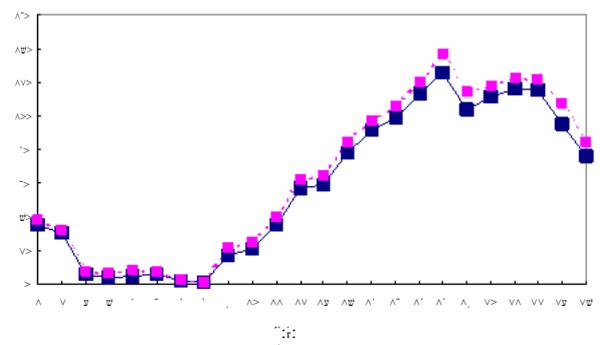


Fig. 4 Time-dependent demands for items and time dependent demands for items sold at internet stores

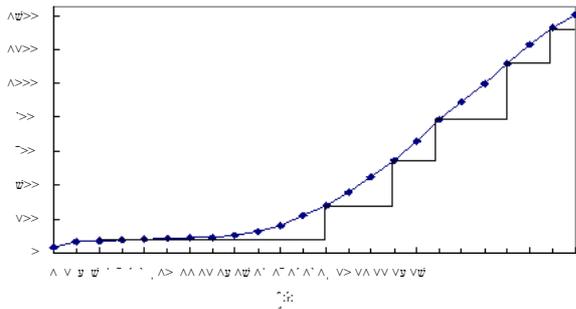


Fig. 5 Cumulative consumer demand for items of internet stores and cumulative delivered items

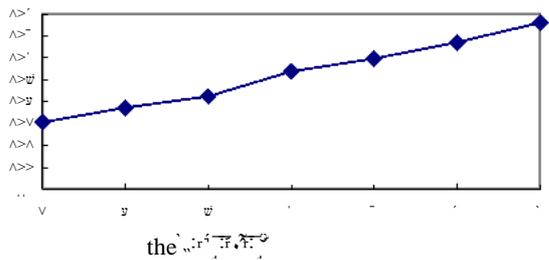


Fig.6 Average logistics cost per item vs. the number of ordering periods

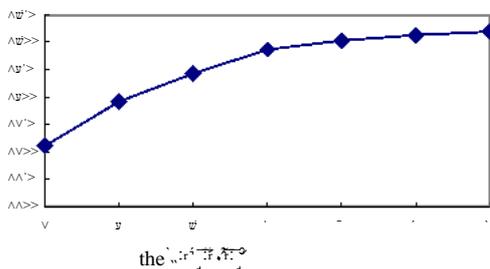


Fig.7 Consumer demand for items of internet stores vs. the number of ordering periods

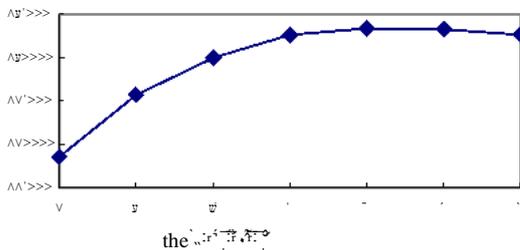


Fig. 8 Profit vs. the number of ordering periods

As shown in Fig. 4, the dotted line represents time-dependent consumer demands for items, while the solid line represents time-dependent consumer demands for items sold at internet stores. Figs. 3 and 5 indicate that there are a large number of items

demanded between 13:00 and 23:00 and indicates that there are also high densities of ordering periods; by contrast, the duration of ordering period is 10 hours at night, implying very low demand during this period. Moreover, as shown in Fig. 6, average logistics cost per item is increasing with the increase of the number of ordering periods during an operating day. However, though consumer demands for items of internet stores indeed increases with the number of ordering periods as shown in Fig. 7, yet the profit is not increasing in the same way but is maximized when there are 6 ordering periods during a day as shown in Fig. 9. Moreover, the optimal batch ordering time made by the internet store operator to the supplier is 0.5 hour before the deadline of each ordering period.

Table 5 lists the optimal objective function values under different values of fixed transportation cost. The study further performs sensitivity analyses to investigate how average logistics cost per item, consumer demand for items sold at internet stores and the total profit of the internet store over the study period are affected by changes in the value of fixed transportation cost as shown in Figs. 9-11. Table 6 presents model results under different values of variable transportation cost per item. Figs. 12-14 show how average logistics cost per item, consumer demand for item sold at internet stores and total profits of the internet store over the study period are affected by changes in the value of variable transportation cost.

Table 5 Model results under different fixed transportation cost

Base value of fixed transportation cost (C)	700	850	1000	1200
Optimal number of ordering periods	7	6	6	6
Consumer demands of internet stores	1414	1403	1403	1403
Average logistics cost (NT dollars)	104.796	105.709	106.907	108.464
Profits (NT dollars)	134710	133331	131819	130582
Ordering periods	0:00~3:00 3:00~13:00 13:00~15:00 15:00~17:00 17:00~19:00 19:00~21:00 21:00~0:00	23:00~3:00 3:00~13:00 3:00~13:00 13:00~16:00 16:00~18:00 18:00~21:00 21:00~23:00	23:00~3:00 3:00~13:00 3:00~13:00 13:00~16:00 16:00~18:00 18:00~21:00 21:00~23:00	23:00~3:00 3:00~13:00 3:00~13:00 13:00~16:00 16:00~18:00 18:00~21:00 21:00~23:00

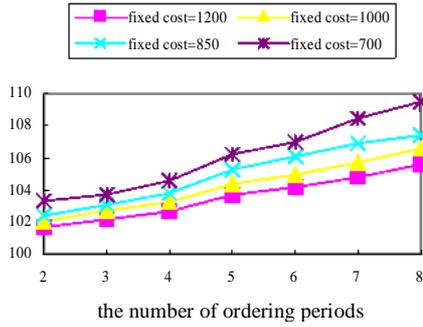


Fig. 9 Average logistics cost per item vs. the number of ordering periods under different fixed transportation costs

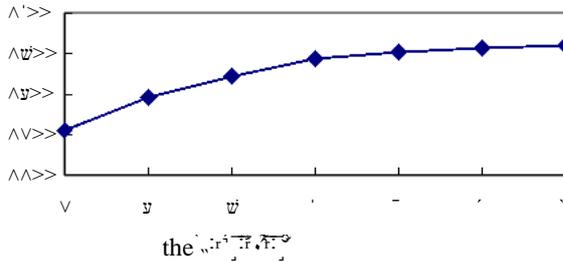


Fig. 10 Consumer demand for items of internet stores vs. the number of ordering periods under different fixed transportation costs

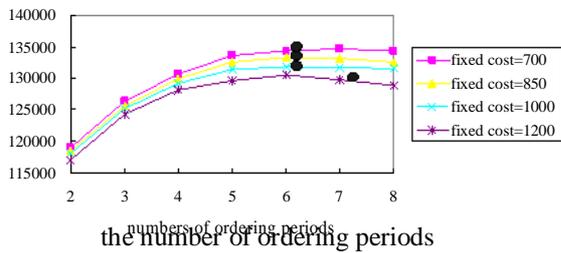


Fig. 11 Profit vs. the number of ordering periods under different fixed transportation costs

Table 6 Model results under different variable transportation costs

Variable cost (r)	85	100	125	150
Optimal number of ordering periods	7	6	6	5
Consumer demand for internet stores	1414	1403	1403	1387
Logistics cost per item (NT dollars)	90.4233	104.967	129.967	153.822
Objective function value (Profits, NT dollars)	154886	133331	98256.2	63145.3
Ordering periods	0:00~3:00 3:00~13:00 13:00~15:00 15:00~17:00 17:00~19:00 19:00~21:00 21:00~0:00	23:00~3:00 3:00~13:00 13:00~16:00 16:00~18:00 18:00~21:00 21:00~23:00	23:00~3:00 3:00~13:00 13:00~16:00 16:00~18:00 18:00~21:00 21:00~23:00	1:00~12:00 12:00~15:00 15:00~18:00 18:00~21:00 21:00~1:00

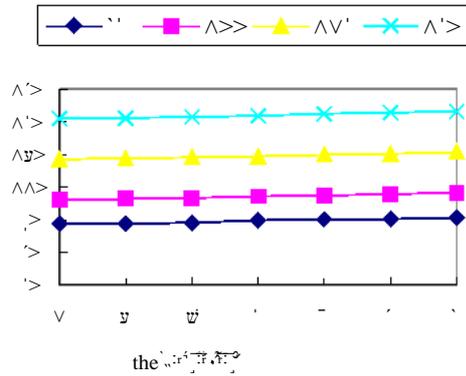


Fig. 12 Average logistics cost vs. the number of ordering periods under different variable transportation costs

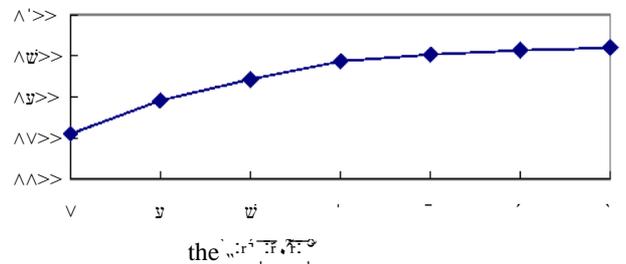


Fig. 13 Consumer demand for items vs. the number of ordering periods under different variable transportation costs

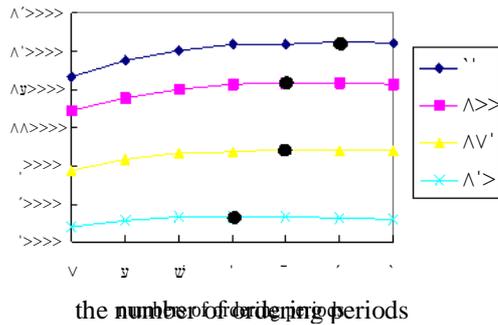


Fig. 14 Profit vs. the number of ordering periods under different variable transportation costs

The higher the value of fixed transportation cost leads to the higher average logistics cost per item and consumer demands for items of internet stores are identical no matter what value of fixed transportation cost is as shown in Figs. 9-10. Fig. 11 shows that a lower value of fixed transportation cost will result in a higher profit and the optimal number of ordering period is 6 no matter the value of fixed transportation cost is, 850, 1000 or 1200 NT dollars, while it is 7 when the value of fixed transportation cost is reduced to 700 NT dollars. Fig. 12 also shows there is a higher average logistics cost per item with the increase of variable transportation cost. Furthermore, it shows that the increased revenues from rising consumer demands for items of internet stores due to increase in the number of ordering periods may not be offset by the impact of the increasing variable cost per item on average logistics cost per item. As a result, the optimal number of ordering periods is 5 when variable cost is 150 NT dollars per item as shown in Fig. 14.

## 5. Conclusions

This study attempts to determine the optimal goods ordering periods for internet stores by considering time-dependent consumer demands and close demand-supply interactions. In order to capture dynamic and time-sensitive consumers, the entire study period is divided into a number of ordering periods with various duration. In the demand side, the study formulates a consumer utility function and then constructs a binary logit model, which determines consumers' choice probabilities between internet shopping and conventional in-store shopping. The expected choice probability of choosing internet shopping is aggregated by a transformation probability density function of individual income based on the logit model. Then, the study further aggregates individual consumer choice probability to estimate the total demand for internet shopping stores by taking into account variations in access time to retail stores, and delay time of receiving ordered goods across different ordering periods. Furthermore, in the supply side, the study formulates transportation costs considering extra cost due to 24 hours business hours of internet stores, and constructs inventory costs reflecting the relationship between the batch ordering of goods, which are made by internet store operators to their suppliers and

continuous ordering of goods, which are made by their consumers. Logistics cost functions for each ordering period are formulated by analytical approach. Then, integrating with the consumer demand model above, a nonlinear mathematical programming model is further formulated to solve the optimal number of ordering periods during the study period by maximizing the internet store profit subject to the demand-supply interaction.

Finally, a case study and sensitivity analysis are provided by R-company in Taiwan to illustrate the application of the models. The results show that there are a large number of items demanded between 13:00 and 23:00 and indicates that there are also high densities of ordering periods; by contrast, the duration of ordering period is 10 hours at night, implying very low demand during this period. Moreover, the internet store operator may change the number and duration of ordering periods in response to time-dependent consumer demand. Average logistics cost per item also may influence the optimal number and duration of ordering periods, in a way that the number of ordering periods decreases with the increase in either variable cost or fixed transportation cost.

In conclusion, this paper formulates an integrated model to determine the optimal number and duration of ordering periods by taking time-dependent consumer demand, and demand-supply interactions into account. These considerations have not yet been theoretically formulated and analyzed in past literature. It is envisaged that the results of the developed models not only shed light on understanding consumers' internet shopping behavior and its relationship with the operators' service strategies, but also provide guidance on marketing, delivery and ordering strategies for internet stores in response to time-dependent consumer demand.

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## References

- [1] Alba, J., Lynch, J., Weitz, B., Janiszewski, C., Lutz, R., Sawyer, A., Wood, S. "Interactive home shopping: consumer, retailer and manufacturer incentives to participate in electronic grocery shopping," *Journal of Marketing*, 1997, 6, 38-53.
- [2] Bakker, A. & Creedy, J. "Macroeconomic variables and income distribution Conditional modeling with the generalized exponential," *Journal of Income Distribution*, 2000, 9, 183-197.
- [3] Ben-Akiva, M., Lerman, S. R. *Discrete Choice Analysis: Theory and Application to Travel Demand*, MIT Press, 1985.
- [4] Burke, R. R. "Do you see what I see? The future of virtual shopping," *Journal of the Academy of Marketing Science*, 1997, 25, 352-360.
- [5] Burns, L. D., Hall, R. W., Blumenfeld, D. E., Daganzo, C. F. "Distribution strategies that minimize transportation and inventory costs," *Operation Research*, 1985, 33, 469-490.
- [6] Blumenfeld, D. E., Burns, L. D., Diltz, J. D., Daganzo, C. F. "Analyzing trade-offs between transportation, inventory and production costs on freight networks," *Transportation Research*

- B, 1985, 19, 361-380.
- [7] Daganzo, C. F., Newell, G. F. "Configuration of physical distribution networks," *Networks*, 1986, 16, 113-132.
- [8] Daganzo, C. F. *Logistics System Analysis*, Springer-Verlag Press, Berlin, Heidelberg, 1991.
- [9] Hall, R. W. "Direct versus terminal freight routing on network with concave cost," *Transportation Research B*, 1987, 23, 37-45.
- [10] Kiang, M. Y., Raghu, T. S., Shang, K. H. M. "Marketing on the internet—who can benefit from an online market approach," *Decision Support Systems*, 2000, 27, 383-393.
- [11] Koppelman, F., Salomon, I., Proussaloglou, K. "Teleshopping or store shopping? A choice model for forecasting the use of new telecommunications-based services," *Environment and Planning B: Planning and Design*, 1991, 18, 473-489.
- [12] Leeftang, P. S. H. & van Raaij W. F. "The changing consumer in the European Union: A "meta-analysis"," *International Journal of Research in Marketing*, 1995, 12, 373-387.
- [13] Lee, D. H., Kim, S. H., Ahn, B. S. "A conjoint model for internet shopping malls using customer's purchasing data," *Expert Systems with Application*, 2000, 19, 59-66.
- [14] Liang, T. P. & Huang, J. S. "An empirical study on consumer acceptance of products in electronic markets: a transaction cost model," *Decision Support Systems*, 1998, 24, 29-43.
- [15] Manski, C. & Salomon, I. "The demand for teleshopping: An application of discrete choice models," *Regional Science and Urban Economics*, 1987, 17, 109-121.
- [16] Khouja, M. "The evaluation of drop shipping option for e-commerce retailers," *Computer & Industrial Engineering*, 2001, 41, 109-126.
- [17] Nagurney, A., Dong, J., Mokhtarian, P. L. "Teleshopping versus shopping: A multicriteria network Equilibrium framework," *Mathematical and Computer Modelling*, 2001, 34, 783-798.
- [18] Huppertz, P. "Market changes require new supply chain thinking," *Transportation & Distribution*, 1999, 40, 70-74.
- [19] Pavitt, D. "Retail and the super high street: the future of the electronic home shopping industry," *International Journal of Retail & Distribution Management*, 1997, 25, 38-43.
- [20] Verhoef, P. & Langerak, F. "Possible determinants of consumers' adoption of electronic grocery shopping in the Netherlands," *Journal of Retailing and Consumer Services*, 2001, 8, 275-285.
- [21] Peterson, R. A., Balasubramanian, S., Bronnenberg, B. J. "Exploring the implication of the internet for consumer marketing," *Journal of the Academy of Marketing Science*, 1997, 25, 329-346.
- [22] Raijas, A. "The consumer benefits and problems in electronic grocery store," *Journal of Retailing and Consumer Services*, 2002 9, 107-113.
- [23] Reynolds, J. "Retailing in computermediated environments: electronic commerce across Europe," *International Journal of Retail & Distribution Management*, 1997, 25, 29-37.
- [24] Rowley, J. "Retailing and shopping on the internet," *International Journal of Retail & Distribution Management*, 1996, 24, 26-37.
- [25] Salomon, I. & Koppelman, F. "A framework for studying teleshopping versus store shopping," *Transportation Research A*, 1998, 22A, 247-255.
- [26] Sim, L. L. & Koi, S. M. "Singapore's internet shoppers and their impact on traditional shopping patterns," *Journal of Retailing and Consumer Services*, 2002, 9, 115-124.
- [27] Verhoef, P. C. & Langerak, F. "Possible determinants of consumers' adoption of electronic grocery shopping in the Netherlands," *Journal of Retailing and Consumer Services*, 2001, 8, 275-285.

# Critical Successful Factors of ERP Implementation: A Review

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## Abstract

Recently e-business has become the focus of management interest both in academics and in business. Among the major components of e-business, ERP (Enterprise Resource Planning) is the backbone of other applications. Therefore more and more enterprises attempt to adopt this new application in order to improve their business competitiveness. Owing to the specific characteristics of ERP, its implementation is more difficult than that of traditional information systems. For this reason, how to implement ERP successfully becomes an important issue for both academics and practitioners. In this paper, a review on critical successful factors of ERP in important MIS publications will be presented. Additionally traditional IS implementation and ERP implementation will be compared and the findings will be served as the basis for further research.

Keywords: E-business, ERP, Critical Successful Factors, Literature Review

## 1. Introduction

Recently the focus of IT application has shift from computerization and automation to electronic transaction or the so-called E-business which is regarded as the most important improvement to commercial competition. Therefore, e-business has come into the limelight not only academically but also commercially. The key components of e-business include Customer Relationship Management (CRM), Supply Chain Management (SCM), Enterprise Resource Planning (ERP), E-Procurement, Knowledge Management (KM) and so on [7]. Among these components of e-business, ERP is the backbone of other applications [7][10]. Davenport [4] indicates that ERP integrate all the information flowing through a company- financial and accounting information, human resource information, supply chain management, customer information seamlessly. This integration can overcome the information island problem in traditional IT application and increase efficiency and effective. In addition, with the use of central database, it can promise to provide accurate and real time data in business operation. For traditional businesses, with the adoption of ERP, it can employ the best practice of ERP to reengineer their business process. In contrast, for new established

businesses, it can apply best practice into the templates for their system design. Markus and Tains [10] also indicate that both small and large companies benefit both technically and strategically from investments in ERP. Because of the advantages discussed above, more and more business administrators attempt to adopt ERP recently. In U.S more than 70 percent of Fortune 1000 companies have either begun implementing an ERP systems or plan to do so over the nest few years [7]. In Taiwan, ERP adoption is also becoming more and more popular in nowadays.

Although ERP is a powerful tool for business operations, yet we can find that many businesses have experienced failure in ERP implementation. And those who declared their success in ERP implementation remain suffer different problems after installation. Davenport [4] indicated that the biggest problems of ERP implementation are not technical challenges, but business problems. Although, ERP can deliver great rewards, managers can not afford to ignore the high risks it carry. ERP's implementation is usually more difficult than that of traditional IS, because of the specific characteristics of ERP.

Based on the discussions above, we can find that how to implement ERP successfully becomes a critical issues in the development of e-business. Although many reports had proposed critical successful factors about ERP implementation, we are still in need of a systematic view of this issue, because many papers usually focus on special cases and do not present a substantive theory. Therefore an overview of the critical successful factors of ERP implementation has become crucial for e-business implementation.

In order to provide the basic structure for further studies, this study surveys into numeral journal papers about this issue and analyzes these articles based on the Lucas's [8] perspective. First, the characteristics of ERP are summarized in order to illustrate why ERP implementation is different from other IS implications. Next, the theoretical background of this paper is illustrated and employed for later analysis. Third, the research method of this study will be illustrated. Fourth, analysis method and results will be presented. Finally, the conclusions and limitations of this study will be

discussed.

## 2. The Characteristics of ERP

Markus and Tanis [10] summarizes several characteristics of ERP, each of them with important implications for the organizations that adopt them. These characteristics include:

- (1) Integration.
- (2) Packages.
- (3) Best Practices.
- (4) Business process reengineering.
- (5) Some assembly required.
- (6) The way to integrate legacy system.
- (7) Rapid change.

In contrast to traditional IT applications, ERP is costly and enterprise wide. Therefore, there are more challenges than department wide IT applications. Besides, business always choose package to be the solution for ERP. Therefore, the consequence of ERP implementation is reversed, and ERP customization becomes an important issue. These attributes are different from traditional in-house development IT applications.

## 3. Theoretical Background

### 3.1 The Key to Successful Information System Implementation

Lucas [8] proposes a systematic review about the critical successful factors of IS implication in the book: "Implementation the Key to Successful Information Systems". In this book, Lucas [8] defines information systems as "Information systems provide information to support decision making and control in the organization". Based on this definition, ERP is a kind of IS implementations in the organization. Therefore, based on Lucas's framework, this study will survey and analyze literatures which incorporate ERP critical successful factors.

In the discussions of critical successful factors of IS, we must identify the definitions of IS success first. Lucas [8] had mentioned four different success criteria:

- (1) Time to complete the project/time estimated to complete;
- (2) Actual cost to develop project/budgeted cost for the project;
- (3) User satisfaction;
- (4) The impact of the project on the computer operations of the firm.

In addition, five measures of IS success are often employed by IS research [8]:

- (1) The use of the system;
- (2) User satisfaction;
- (3) Favorable attitudes;
- (4) The degree to which a system accomplishes its original objectives;
- (5) Payoff to the organization from a system.

Lucas [8] defines IS implementation as "an on-going process which includes the entire development of the system form the original suggestion through the feasibility study, systems analysis and design, programming, training, conversion, and installation of the system." In the context of ERP, this sequence is inversed [4]. Because choose among ERP packages is always the solution for ERP implementation. Therefore, the issues about vendor selection, outsourcing contract management, cooperation with outside consultant and so on have become more important than traditional IS implementation.

Different types of implementation research are proposed by Lucas [8] includes theories (insight), surveys of factors, and case study, etc. The relationship between these types of research is illustrated in figure 1.

Lucas [8] also synthesizes past studies into a conceptual framework in order to be the base for understanding IS implementation. Four constructs are included in this framework: Client actions, Technical characteristics, Attitudes toward systems, Decision Style, Personal and situational factors, and successful implementation. This conceptual framework is illustrated in Figure 2.

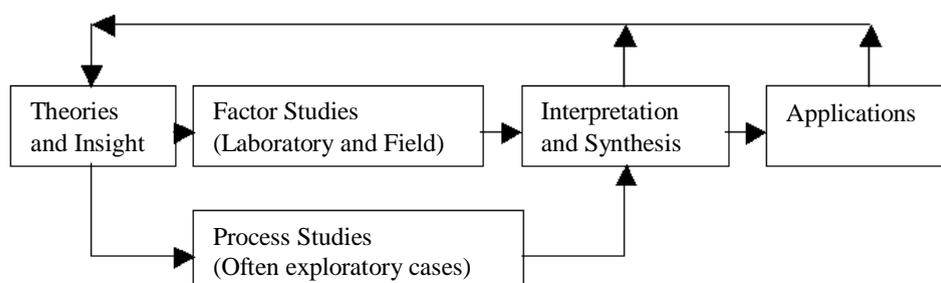


Figure 1. The Implementation Research Process [8]

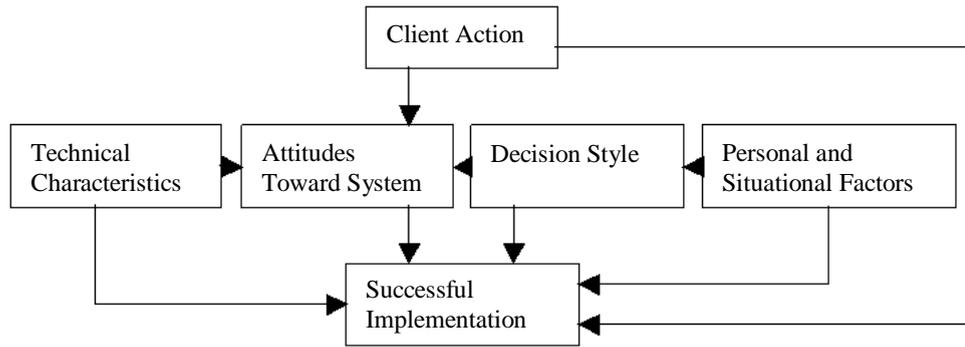


Figure 2. A Conceptual Framework about IS Successful Implementation Factors [8]

### 3.2 Justification of Research Approach

Although Lucas's framework focused on general IS implementations, it can also be applied to a specific IS implementation, especially in the context of ERP implementation. Based on the Lucas definitions about information system and IS success implementation, this study infers that Lucas's framework is still suitable for ERP implementation in general. On the other hand because of the specific characteristics of ERP, there must be some differences between traditional IS implementation and ERP implementation. Therefore, this study attempts to modify this framework based on literatures about ERP implementation successful factors. This study will propose a modified framework that is tailored for ERP implementation.

### 4. Research Methodology

This study is based on a study of journal articles. Conference proceeding papers, master's theses, doctoral

dissertations, textbooks, and unpublished working papers are excluded in this study. This is because only journal articles that we can browse completely from various powerful digital database. In addition, we believe that ERP is new IT implication and most of the newest research results will be published in journals. Journal articles are first hand information and suitable for this study. Three main digital databases are employed in this study, including ABI/INFORM, SDOS and EBSCO Online. Full text papers have been collected from on line PDF files and hard copies from the library.

Selected nine articles in this study are all related to the critical successful factors of ERP implementation. These papers are from Production and Inventory Management Journal, Communications of the ACM, Information Systems Management, IEEE Software, International Journal of Production Economics, European Journal of Information System, Industrial Management, Harvard Business Review. (Table 1.)

Table 1. Summary of Selected Research Papers

Period	Author(s)	Title	Published Journal
2002	Scott and Vessey	Managing Risks in Enterprise Systems Implementations	Communications of the ACM
2002	Motwani et al.	Successful Implementation of ERP Projects: Evidence form Two Case Studies	International Journal of Production Economics
2002	Akkermans and Helden	Vicious and Virtuous Cycles in ERP Implementation: A Case Study of Interrelations Between Critical Successful Factors.	European Journal of Information Systems
2002	Umble and Umble	Avoiding ERP Implementation Failure	Industrial Management
2001	Weston	ERP Implementation and Project Management	Production and Inventory Management Journal
2000	Willcocks	The Role of the CIO and IT Functions in ERP	Communications of the ACM
1999	Bingi et al.	Critical Issues Affecting an ERP Implementation	Information Systems Management
1999	Holland and Light	A Critical Success Factors Model for ERP Implementation	IEEE Software
1998	Davenport	Putting the Enterprise Into the Enterprise Systems	Harvard Business Review

## 5. Analysis Method

The analysis framework of this study is based on Lucas's [8] framework that is shown in Fig. 1. Five constructs of this framework are: (1) Client Actions, (2) Technical Characteristics, (3) Attitudes toward Systems, (4) Decision Style, and (5) Personal Situational Factors.

### 5.1 Client Actions

Two variables in the client actions class are extremely important in this dimension: management support and user involvement and influence [8].

### 5.2 Technical Characteristics

Technical variables can be divided into two main categories, which are absolutely mandatory for success and can greatly enhance the appeal and usefulness of a system. Variables in the first category include accuracy of input and output, reliability of an online system, the completion of processing on schedule for a batch system etc. Variables in the second categories such as the design of interface can be used to encourage use and satisfaction with the system [8].

### 5.3 Attitudes Towards Systems

Lucas [8] indicates that the attitude toward a specific stimulus like the input and output equality of a computer system is a good predictor of the use of a voluntary system or satisfaction with a mandatory systems. Besides, Davis et al. [5] also indicates that user attitude has positive effect on user intention to use computer technology. And user intention is the predictor of user behavior. Therefore, user attitudes will play an important role in IS successful implementation.

### 5.4 Decision Style

Decision style is the characteristics people have to deal with a decision problem, and this set of variables will affect IS implementation and the use of computer-based information system. Variables included in this category are personal cognitive style and complexity, etc [8].

### 5.5 Personal Situational Factors

The difference of personal variables such as age, education, length of time in the company, etc, can greatly influence the success of implementation [8]. Davis et al. [5] also indicates that when discussing about user acceptance of IS, external variables in Technology Acceptance Model (TAM) play an important role in IT acceptance. Individual difference is one of the categories of external variables and these characteristics will affect the success of IT implementation. Agarwal and Prasad [1] also propose similarly. They insist that individual differences are important factors in IT acceptance.

To summary the discussions above, we find that if we want to understand how to implement an information system successfully, we need an overall consideration. Factors of different levels are included in Lucas's framework: Managerial Level, Technical Level, and Personal Level.

## 6. Analysis Results

A total of nine articles were included in this analysis. This study analyzed the identified articles by year of publication, research method employed, case selected, critical successful factors proposed by selected articles, and key dimensions of ERP implementation.

### 6.1 Year of Publication

From Table 2 we can find that, the starting year of ERP CSF (Critical Successful Factors) related research publication appeared in 1998. In that year, Davenport's research "Putting the Enterprise into the Enterprise System" that was published in Harvard Business Review. This paper became one of the pioneers of ERP research. Besides, in the mid 2002, there are four papers about ERP CSF published in journals. From this trend, we find that ERP attracts more and more researchers recently

Table2. Year of Publication

Year	1998	1999	2000	2001	2002	Total
Count	1	2	1	1	4	9

### 6.2 Research Methods Employed by the Selected Papers

As regards to the research methods employed by the selected papers, we divide the selected articles into three categories based on Implementation Research Process [8] perspective: case study, factor studies, and theories/insight. Case study is the method that has often been used in ERP CSF studies (Table 3). The reasons for this phenomenon include:

- (1) ERP has just been proposed in recent years, so we still have to collect more samples into our data bank.
- (2) With sparsely data, we don't have enough information to do quantitative study.
- (3) For some business, ERP is a kind of strategic information system, therefore few enterprises want to release the corporate confidential information.

In addition to case studies, many author's simply presented their insight or experience. From table 3, we find that none of research conducts the empirical study. Therefore it is recommended that further studies be try to collect data from business.

### 6.3 Cases Selected

From the above discussions, we can find that case study is the most popular research method so far. The cases conducted in the past are arranged in Table 4.

### 6.4 Critical Successful Factors of ERP Implementation

The selected articles have proposed sixty-eight critical successful factors (Table 5). Of course, these variables are overlapping and we will analyze them in the next section.

**Table 3. Research Methods Employed by the Selected Papers**

Research Method	Case Study	Survey Study	Theories/Insight	Total
Papers	Davenport [4]; Holland and Light [6]; Akkermans and van Helden [2]; Motwani et al. [11]; Scott and Vessey [12]	N/A	Bingi et al. [3]; Willcocks [15]; Weston [14]; Umble and Umble [13]	
Count	5	0	4	9

**Table 4. Cases Selected**

Papers	Cases Selected
Davenport [4]	Elf Atochem Inc.
Holland and Light [6]	Threads Inc. and Statco Inc.
Akkermans and van Helden [2]	Two anonymous cases (medium-sized manufacturing firm in the aviation industry)
Motwani et al. [11]	Two anonymous cases (Pharmaceuticals industry and Footwear industry)
Scott and Vessey [12]	Dow Corning Inc. and FoxMeyer

**Table 5. Critical Successful Factors of ERP Implementation**

Authors	Critical Successful Factors
Davenport [4]	(1) Careful deliberation (2) Top management directly involved in planning and implementing
Holland and Light [6]	(1) Strategic Factors (Legacy systems, Business vision, ERP strategy, Top management support, Project schedule and plans) (2) Tactical Factors (Client consultation, Personnel, BPC and software configuration, Client acceptance, Monitoring and feedback, Communication, Trouble Shooting)
Bingi et al. [3]	(1) Top management commitment (2) Reengineering (3) Integration (4) ERP consultants (5) Implementation time (6) Implementation costs (7) ERP vendors (8) Selecting the right employees (9) Training employees (10) Employee Morale
Willcocks [15]	(1) Senior-level sponsorship, championship, support and participation (2) Business themes, new business model and reengineering drives technology choice (3) Multifunctional teams, time box philosophy, regular business benefits (4) CIO as strategic business partner (5) Nine core IT capabilities retained/being developed in-house (6) In-house and insourcing of technical expertise preferred (7) Supplier partnering (strong relationships and part of team) (8) ERP perceived as business investment in R&D and business innovation rather than primarily as a cost-efficiency issue.
Weston [14]	(1) Top management and cross-functional support (2) Project proposal (3) Clear deliverables (4) Clear assessment of business risk (5) Strong project manager and sound project plan (6) Awareness of the dangers of scope creep (7) Change management process (8) Training
Umble and Umble [13]	(1) Strong leadership provided by an executive management planning committee (2) The implementation is viewed as an ongoing process (3) Implementation teams are composed of the company's best workers representing all functions (4) Mid-level management is totally involved in the implementation (5) Excellent project management techniques are used (6) The old systems are eliminated (7) Proper measurements are implemented and closely monitored (8) An aggressive but achievable implementation schedule is established (9) Successful change management techniques are applied (10) Extensive education and training is provided.
Akkermans and van Helden [2]	(1) Top management support (2) Project team competence (3) Interdepartmental co-operation (4) Clear goals and objectives (5) Project management (6) Interdepartmental communication (7) Management of expectations (8) Project champion (9) Vendor support (10) Careful package selection.
Motwani et al. [11]	(1) Incremental, bureaucratic, strategy led cautious implementation process (2) Cultural readiness (3) Inter-organizational linkages (with the vendor) (4) Careful change management
Scott and Vessey [12]	(1) Organizational culture (2) Project management (3) Excellent business vision (4) Strong leadership (5) Stand the company in good stead

## 6.5 Dimensions of ERP Critical Successful Factors

In Table 5, we have arranged these factors into fourteen main critical factors based on the frequency that are proposed by the selected articles (Table 6). Based on the results in Table 6, we find that the top five factors are: Project Management, Top/Middle Management Support, Business Vision, Personnel/Employee/Acceptance, and Vendor Selection.

In order to understand the similarities and differences between ERP and traditional IS applications, fourteen categories from Lucas's [8] framework (Figure 2) are compared in Table 7 in which Client Actions is highly correlated between these two contexts. Yet in Lucas's framework, Decision Style and Personal Situational Factors are not emphasized in the domain of ERP. Other factors that are emphasized in the context of ERP are not equally emphasized by Lucas's framework. We can find that these specific factors are caused by the specific characteristics of ERP, therefore they may not be the key successful factors of traditional IS implementation.

**Table 6. Main Critical Successful Factors**

Categories	Frequency
Top/Middle Management Support	8
Project Management	14
Business Visions	6
BPC/BPR	3
Change Management	3
Careful Deliberation	2
Consultants	3
Personnel/Employee/Acceptance	4
Vendors Selection	4
Training	3
Project Team	3
Culture	2
Legacy System	2
Others	11

**Table 7. Comparison of CSF Between Traditional IS Implementation and ERP Implementation**

Dimensions of Lucas's Framework	Dimensions of Author's Arrangement
Client Actions	Top/Middle Management Support Project Team
Technical Characteristics	Legacy Systems
Attitudes Toward Systems	Personnel/Employee/Acceptance
Decision Style	N/A
Personal Situational Factors	N/A
N/A	Project Management
N/A	Business Vision
N/A	BPC/BPR
N/A	Change Management
N/A	Careful Deliberation
N/A	Consultants
N/A	Vendor
N/A	Training
N/A	Culture

## 7. Conclusions

Since the critical successful factors of ERP implementation are focused in this survey. Based on our analysis, we conclude the following points:

(1) Critical successful factors in traditional IS implementation and ERP implementation are not

exactly the same.

(2) Three of the five dimensions proposed by Lucas [8] are often used to explain the success of ERP implementation.

(3) In the selected papers, case study is the most commonly utilized method to understand critical

successful factors of ERP implementation.

- (4) Although critical factors have been arranged into fourteen categories, but we are still lack of a well-defined theory to understand their relationships.
- (5) Based on the results of this study, we suggest that future study should do survey research that focus on a cross-sectional field study.

## 8. Limitations

The main limitation of this study is that only three digital databases are used to collect related studies, some omissions may occur. In addition, theses, dissertations, textbooks, and conference proceedings papers are not included in this study. It is possible that other related studies are included in the above materials. However, we have included all major MIS publications in our study.

## References

- [1] Agarwal, R. and J. Prasad, A Conceptual and Operational Definition of Personal Innovativeness in the Domain of Information Technology, *Information Systems Research*, Vol.9, No.2, (1998), pp. 204-215.
- [2] Akkermans, H. and K. van Helden, Vicious and Virtuous Cycles in ERP Implementation: A Case Study of Interrelations Between Critical Successful Factors, *European Journal of Information Systems*, Vol.11, (2002), pp.35-46.
- [3] Bingi, P. et al., Critical Issues Affecting an ERP Implementation, *Information Systems Management*, Vol.16, No.3, (1999), pp. 7-14.
- [4] Davenport, T. H., Putting the Enterprise into the Enterprise System, *Harvard Business Review*, (July-August 1998), pp.121-131.
- [5] Davis F. D. et al., User Acceptance of Computer Technology: A Comparison of Two Theoretical Model, *Management Science*, Vol.35, No.8, (1989), pp. 982-1003.
- [6] Holland, C. P. and B. Light, A Critical Success Factors Model for ERP Implementation, *IEEE Software*, Vol.16, No.3, (1999), pp. 30-36.
- [7] Kalakota, R. and M. Robinson, *e-Business Roadmap for Success*: Addison-Wesley, 1999.
- [8] Lucas, H. C., *Implementation The Key to Successful Information Systems* : Columbia University Press, 1981.
- [9] Markus, M. L. et al., Multisite ERP Implementations, *Communications of the ACM*, Vol.43, No.4, (2000), pp. 42-46.
- [10] Markus, M. L. and C. Tanis, The Enterprise System Experience- From Adoption to Success, in *Framing the Domains of IT Management- Projecting the Future...Through the Past* (Zmud edited): Pinnaflex Educational Resources, 2000.
- [11] Motwani, J. et al., Successful Implementation of ERP Projects: Evidence from Two Case Studies, *International Journal of Production Economics*, Vol.75, No. 1-2, (2002), pp.83-96.
- [12] Scott, J. E. and I. Vessey, Managing Risks in Enterprise Systems Implementations, *Communications of the ACM*, Vol.45, No.4, (2002), pp. 74-81.
- [13] Umble, E. J. and M. M. Umble, Avoiding ERP Implementation Failure, *Industrial Management*, Vol.44, No.1, (2002), pp. 25-33.
- [14] Weston, F. C., ERP Implementation and Project Management, *Production and Inventory Management Journal*, Vol.42, No.3/4, (2001), pp. 75-80.
- [15] Willcocks, L. P., The Role of the CIO and IT Function in ERP, *Communications of the ACM*, Vol.43, No.4, (2000), pp. 32-38.

# Integrated Collaborative Planning Within the Supply Chain: The Future of ERP

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## Abstract

By examining case studies using Collaborative Planning it becomes apparent the need to integrate with Enterprise Resource Planning applications. This process would help avoid errors, save time, and produce cost reductions across the supply chain.

## Introduction

Enterprise Resource Planning (ERP) has become a boon to many corporations with its ability to integrate information systems through out a corporate structure. By using central databases and information sharing, departments can save money, reduce time for different operations, improve communication, improve customer service, and reduce errors. With ERP's success on the corporate level, it has become apparent that a benefit can be obtained by integrating the supply chain in the same fashion. This year PeopleSoft and SAP have introduced new modules to help companies manage supply chain integration. Collaborative Planning is the technology needed to advance corporations in the future.

## The Bull Whip Effect

The bullwhip effect happens when a constant demand becomes varied throughout the supply chain. This phenomenon happens because of lack of communication and each member of the supply chain must make their own forecast based on the current demand of the other members. If a retailer forecast the inventory levels that they need and pass this demand on to the wholesaler, then the wholesaler will make forecasts based on the new demand from the retailer. Since the data was achieved from a forecast and not actual sales or POS data, most likely the forecast will be off. Now, when the wholesaler places an order with the distributor with the newly skewed numbers, the wholesaler will make an erroneous forecast since their demand data is incorrect. They will pass on the distorted demand to the factory. This effect causes peaks and valleys in the ordered. This happens because when the retailer orders too much and it is multiplied throughout the supply chain, it creates a surplus. Now that there is a surplus the members tend to overreact and order to little, but at the same time that number is diminished each step in the supply chain causing

a shortage. By sharing sales data between the members they can better forecast together what the demand will be, thus defeating the bull whip effect.

There are many benefits by attacking the bullwhip effect that the members can realize. By smoothing out the ordering demand and eliminating the peaks and valleys that are associated with the bullwhip effect, CPFR can help increase the retail in-stock levels [3]. A retailer increases sales when they increase the in-stock level because they do not lose potential sales. This also gives the power to incorporate category management strategies, which in turn allow for better product mix and promotional timing. Retail outlets can also carry lower safety stock since the forecasted data will be more accurate. This also creates a new operating platform for the manufactures. Before they were in a push system where they would create the product and push it on the customer. Now they can move to a pull environment where they pull the demand from the customer. This is also a make-to-demand model compared to a make-to-stock model. The advantage in this is that safety stock for all members is decreased, while inventory cost decreases simultaneously. Greg Belkin of Retailsystems.com suggests another benefit of CPFR is that it crash-proofs the supply chain. Since the data is in real time, companies can respond quickly to extreme changes in the supply chain, including the loss of a distribution center. Because the members of the supply chain have a real time collaboration tool, they can jointly solve the problem and rectify the problem quickly. Belkin as states that a company's stock price can drop on average 8.62% on news that there has been a disruption in their supply chain.

Decreased inventory levels translates to freed up capital. Since less warehouse space is needed, less money needs to be invested into buildings. Fewer inventories are purchased at one time freeing up more money for the company. This can lead to being out of debt. It also opens many doors for the company as they may increase marketing budgets, increase research and development, or spend more money on quality testing.

## CPFR: A Viable Solution

CPFR stands for Collaborative Planning, Forecasting, and Replenishment. "CPFR [is] a web-based standard that enhances vendor managed inventory and continuous

replenishment by incorporating joint forecast” [9 p.239]. The process involves two or more companies comparing their historical data, such as demand, sales, and inventory levels. The two companies can then compare where there are differences of discrepancies and work together to create better forecast. The overall goal of CPFR is to synchronize all the members of the supply chain. The goal is to open up the communications between members of the supply chain and allow for better forecasting. Information that is shared between the members is past sales trends, scheduled promotions, and forecasts. BusinessWeek.com reported that companies could enjoy a three-point increase in their overall profit margin by implementing CPFR. The ultimate goal of CPFR is to provide more accurate information that can add value to the supply chain by increasing sales and profits.

The main benefit of this process is it attacks the bullwhip effect. As can be seen later in the Heineken case, better forecasting and planning were achieved. Lead times were reduced which led to better customer service. Processes and procedures became automated and required less human effort. This also improved their inventory management as well.

#### Rosettanet

Rosettanet takes the benefits of XML and EDI while omitting their drawbacks. EDI's strong point is that it consists of strict standards. These standards make it possible to easily program applications that can abide by the rules set forth by the EDI standards. This also makes it possible for generic applications that can be implemented throughout the supply chain. XML's strong points are the fact that it can be deciphered by humans, codes are replaced with descriptive tags, an HTML capable browser can easily read the files, thus allowing for easy transfer over the Internet.

Rosettanet uses dictionaries that contain the standard tag definitions used in XML files. For example, referTo will always mean the partner to which a business document request is being referred. And anytime the partner to whom a business document request is being referred will always be listed in a referTo XML tag. True a tag named address would be easily recognized by the human eye and be deciphered to what it means, however a computer must be programmed to know what address means. By making these dictionary files the computer can comprehend what the data means and how to interpret it. All members of the supply chain agree upon these dictionary standards.

#### Heineken: Implementing Supply Chain Integration

In 1997 Heineken launched a pilot program that took

advantage of the Internet. Heineken had many problems before the new pilot was launched. There was very inefficient communication through out the supply chain. This led to many problems that were associated with the bullwhip effect. Heineken had a police-like relationship with many of its customers and distributors. Lead times were excessive and this led to outdated products being purchased by consumers. Forecasts were inaccurate as it overwhelmed the sales force with paperwork. Inventory management was inconsistent. With these problems in mind, Heineken had decided that they needed a new solution to fix these problems. In 1996 they teamed up with Logility to tackle this problem. The challenge set forth for Logility was to make most processes integrated. This included creating tools that would allow marketing planning and sales planning to communicate. Elimination of data collection by fax needed to become a reality. Inventory management needed to be fixed. Automated processes needed to be installed that would eliminate manual processing.

The plan was based off of creating a central planning organization that was created from the bottom up. This plan would drive the initial forecast for all areas. This way every department would be working with the same numbers and goals. The forecasts were also shared with the distributors, since they have knowledge of their respective markets they could communicate any errors in the forecast. Since computers did the ordering based off the forecast, less human labor would be required and errors could be prevented. The system would also communicate marketing and promotional information to distributors. This would allow the distributors to expect an increase in demand while the promotions were active.

Forecasts were made based off of consumer data. By collecting sales inputs, Heineken would be able to integrate it with marketing plans, financial goals, company objectives, and various strategic plans. Logility designed a pyramid structure that supported forecasting information from remote and distributed sources. It then merges the data and each department can have access to it.

#### Summary of other Benefits

Heineken realized many other benefits as well. Forecasting and planning improved. Customer service improved overall. Self-regulating order planning became plausible. Heineken was able to adjust for inventory variances that were due to forecasting errors. Inventory management improved. Lead times decreased, which in turn also increased customer service. Most processes and procedures became automated reducing the number of manual tasks. Communication became a stronger and more focused tool. It gave the perception that Heineken was a leader.

## Dell Computers and Agile Software

Dell Computers makes customized computers with orders that are fulfilled in a goal of five days. Dell wished to improve margins, market shares, and response to its environment. Dell strived to help ensure rapid, error-free manufacturing and delivery of the exact products specified by the customer using CPFR with their parts suppliers. To accomplish this task Dell used Agile Software Anywhere Software Suite. This software helped ensure that the parts suppliers delivered the correct part at the right time. The Internet is the backbone of this process [1]. “[T]he result has been super-charged growth -- as competitors have lagged.” [11]

Agile Anywhere software suite consists of five software titles that help automate and distribution and synchronization of product information. The first application is called Agile eHub. This program handles storage, web distribution, and administration or product information that is available to all members of the e-supply chain. Agile Product Change Server automates the routing and notification of engineering changes. Agile AML Server links manufacturers with Dell and allows Dell to monitor and approve new products. Agile Product Definition Server provides a web-based environment that manages parts, documents, Bills of Materials, and drawings. [1]. The advantage of the Agile Anywhere software is that Dell and its parts suppliers can easily collaborate over the Internet.

## i2 and Home Depot

Home depot was looking for a way to plan collaboratively with their suppliers to manage truckload capacity. Though there are many economic advantages to this, Home Depot was concerned about improving service. Home Depot enlisted the services of i2 Technologies. By using i2's carrier bid optimizing solution, Home Depot was able to request bids for truckloads as suppose to less-than-truckloads orders. The carriers would then return bids. Home Depot then analyzes the bids and can begin negotiations with the suppliers. This helps Home Depot provide lower prices [6].

Before 1996, Home Depot had a completely manual system used for bidding on lanes. In 1996 they allowed carriers to place their bid on excel spreadsheets. However, even the new system they devised did not allow carriers access to Home Depot's demand. Because of this flaw, a carrier would have to assume that the demand would stay relatively constant throughout the year, thus skewing their forecasting abilities. Another drawback was the fact that carriers could not bid on a group of lanes that they could better optimize. If the carrier had more lanes, they could fill the trucks fuller. However, it would become uneconomical if they did not win the bid on a lane that was in the middle of other lanes that they had won the bid on.

In January 2000, i2 created an Internet based bidding system that allowed important access to some of Home Depot's data. Detailed information about lanes was provided, including exact origin and destination data. Before, only the zip code was provided. Demand forecast were also provided which allowed bidders to better analyze the situation and to better forecast their cost.

By using collaborative management, Home Depot was able to get better rates overall for their transportation needs. The carriers also reported that they were overall happier with the new system. Even though they were charging less, they were able to make more profit because they could manage their business better with informative data that Home Depot provided. The main complaint that the carriers had was that the training was too short, but overall the program was a success.

## Why ERP?

ERP becomes the choice medium for Collaborative Management because it already compromises the data and applications that need to be used. Since ERP vendors such as PeopleSoft have converted to applications based off the Internet it becomes possible to easily augment the ERP software to better cater to Collaborative Planning. By implementing such standards such as Rosettenet and CPFR, an ERP vendor can create a portable application that can be used by all members in the supply chain and still communicate with the ERP software.

It must also be noted that the most important pieces of data include marketing and promotions, inventory levels, sales, and forecasted demand. This list is already handled by ERP software and the data is readily available. To create a stand-alone application would require extra data conversion and may be hindered by software upgrades that can hinder the data communication between the ERP database and the stand-alone application.

## Just In Time

Collaborating can reduce Just In Time cost. If the supplier can better forecast the demand of the manufacture, the supplier can in turn reduce their safety stock requirements and better forecast labor, reducing their cost that can be passed on to the manufacture. Using ERP software to share promotions and historical data, the supplier can create better forecast. Other functions such as purchasing may be handled automatically.

## Problems Associated With Collaborative Management

The biggest issue that arises with collaborative management is trust. Many managers do not wish to share viable information. There is a real concern because a leak of

this information can hurt the company's competitive advantage. To combat this both parties may need to understand the value that will be acquired by this process. A commitment of trust needs to be established. Also, software can be used to analyze actual shipments and shared data to double check numbers that are being shared.

## Conclusion

The future of ERP is defiantly headed into the direction of collaborative planning. This practice allows each member of the supply chain to share the cost of a single process instead of each member having to pay for the exact same process, doubling the total cost. Also many cost advantages appear when each member of the supply chain makes better forecast. It may be concluded that this competitive weapon may beat those firms that do not practice collaborative planning.

## References

- [1] BusinessWeek.com "Agile Software Helps Deliver Anywhere"  
<http://www.businessweek.com/adsections/chain/2.1/agile.html>
- [2] Browsersox, Donald J., Closs, David J., Cooper, Bixby M. Supply Chain Logistics Management. McGraw Hill. Boston. 2002.
- [3] Co, Henry. "CPFR: Collaborative Planning, Forecasting, and Replenishment."  
<http://www.csupomona.edu/~hco/EBZLectures/04b-CPFR.ppt.11.AUG.2002>.
- [4] Halpern, Mark. "i2 Helps The Home Depot Keep Promises."  
<http://www.businessweek.com/adsections/chain/2.1/i2.html>.
- [5] PeopleSoft. "Collaborative Supply Chain Management: The Internet Advantage." PeopleSoft Inc. January 2002.
- [6] "Home Depot: An Experiment In LTL Carrier Management."  
<http://www.supplychainbrain.com/archives/7.01.homedepot.htm?adcode=5>
- [7] Rosettanet Business Directory  
<http://www.rosettanet.org/businessdictionary>
- [8] Sandoe, Kent, Corbott, Gail, Boykon, Raymond. Enterprise Integration. John Wiley And Sons, Inc. New York. 2001.
- [9] Simchi-Levi, David, Kamivsky, Phillip, Simchi-Levi, Edith. Designing And Management the Supply Chain: Concepts, Strategies, and Case Studies. Irwin McGraw-Hill. Boston. 2000.
- [10] Technology for Transportation Bidding at the Home Depot."  
<http://silmaril.smeal.psu.edu/interfaces/ebiz/HomeDepot.pdf> 14 NOV 2000.

- [11] Taulli. "Agile Software: Living Up to Its Name."  
[http://www.internetstockreport.com/column/article/0,1785,1661\\_325861,00.html](http://www.internetstockreport.com/column/article/0,1785,1661_325861,00.html).

# A Case Study of ERP Implementation Issues

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## Abstract

We discuss strategic issues related to deploying Enterprise Resource Planning (ERP) systems in terms of their applications, suggested benefits, and proven failures. After this broad explanation of ERP systems as they pertain to today's business world, attention focuses to the difficulties in implementing SAP ERP systems in a Midwestern business. Finally, a review of recommendations for increasing Return on ERP Investment is provided.

## 1. Introduction

Enterprise Resource Planning (ERP) systems are hot issues in today's "costs at a minimum, profits at a maximum" business world. In fact, a recent study predicts that the ERP market will expand at a compounded annual growth rate of 11 percent to reach \$25 billion by 2004 [4]. This is attributed largely to the fact that once a business can get past the kick in the pocketbook they take when implementing the system, ERP provides the business with an integrated suite of computer applications that result in a seamless flow of information across the organization with promises of future cost savings. Post implementation, newfound efficiency, and effectiveness from this "seamless information flow" are some acclaimed ERP benefits that are the drivers of the cost savings [3].

### 1.1. Benefits

While one might view ERP systems as merely improving or updating existing technology (as was the case at the time of Y2K), many business managers believe that ERP systems are implemented for far more significant strategic reasons [1]. Some of these well-known benefits are as follows:

- Cross-functional business processes are brought to the forefront and allow information to be shared horizontally, between functions and business units; and vertically, from the front-line to the strategic levels,
- Operating costs are reduced,
- Production cycles speed up,
- Identification of excess inventories/better management of inventories,
- Improved customer satisfaction by improving late deliveries and customer service resources,

- ERP-enabled business processes and data are standardized and normalized,
- Organizational boundaries dissolve – creating a business where departments are constantly "talking" to one another,
- Independent business units are integrated – forming one business unit,
- Jobs broaden and/or are redefined via expanded information access,
- The availability of information fosters empowerment of employees,
- There is system-wide accountability and visibility that helps to ensure people do things right the first time,
- More accurate demand forecasts are generated.

### 1.2. Who Benefits?

Charlie Rooney, a partner at Orr & Boss, Inc. consulting firm in Plymouth, Michigan identifies the following six major internal factors that determine whether or not ERP should be implemented in an organization [5].

1. If its supply chain includes multiple distribution centers and plants, an ERP system is almost essential.
2. If its manufacturing is capital intensive, ERP will have a larger impact due to its ability to manage peaks of demand by building inventory for forecast sales.
3. With complex production processes that have many levels of intermediate products, ERP systems can help control inventory while avoiding stock outs.
4. Where set up and clean up are a major part of total cost, the ability of an ERP system to aggregate demand and control the number of batches helps minimize cost.
5. ERP systems can cut transportation costs by using Demand Requirements Planning to ensure that warehouses are supplied from the plant that can do so at the lowest total cost. They also minimize freight out by aggregating shipments and enforcing discipline in choice of carriers. This is important in industries like consumer caulk, where transportation cost is a major portion of total supply chain costs, and
6. If the company has built up a fragmented set of legacy systems over the years may be sufficient

reason to upgrade to an ERP package. Modern systems can do so much more, and there are great advantages to working from a common database.

### 1.3. The Failures

While ERP benefits are sought after in today's productivity and efficiency oriented corporate climate, they do come at a price, and sometimes it is more than what the investors were expecting to take on. In fact, the current consensus is that many companies have failed to reap the significant benefits that a massive investment in ERP warrants. The question that arises is why? Below are some reasons are that ERP projects have failed to bring the expected results.

- They represented very large investments for the organizations concerned,
- They have been very painful to implement and left the organization drained and resistant to launching further projects,
- They have not taken into consideration the all the hidden costs in the form of the internal resources deployed and the consequent loss of focus on the business associated with an implementation, and
- They delivered limited business benefits over and above installation of new base systems infrastructure.

The following situations add to the notion that, historically, organizations have not been able to recognize all the benefits ERP has to offer:

- Organizations develop over-ambitious project plans that underestimate the scale and degree of difficulty of implementing ERP. Then when the magnitude of the task becomes clear, the organization scales back and sacrifices benefits,
- There is a bandwagon effect whereby projects are pushed through with flimsy business cases and the claim that, because everybody else in the sector is implementing ERP, it must be the right thing to do, and
- Since ERP is so expensive to implement, many try to minimize cost by reducing the amount of business change involved.

The reality that must be faced now is that organizations must take action – brainstorming solutions that will allow them to realize the benefits of an investment in ERP [6].

## 2. Difficulties and Issues in ERP Implementations

Company XYZ, a Midwestern multi-national company operates five major manufacturing facilities and ten minor facilities worldwide. XYZ elected to implement the SAP Enterprise Resource Planning Software in order to integrate its facilities and improve:

- Their current slow and dysfunctional New Product Development Process,
- Customer Focus (specifically for Large Accounts),
- Operating Systems efficiency: it operated five independent computer systems which required high maintenance,
- Business structure: it had functional silos.

To solve these problems, XYZ decided to assemble a "Customer First" Team to address the future needs of the business. The team was made up of project management and a project team. The objectives of the first phase of the Customer First team were to:

- Identify customer expectations (for external and internal customers),
- Understand the current processes,
- Identify improvement opportunities,
- Determine future process vision, targets, and goals, and
- Develop a Vision

XYZ met these objectives by conducting 220 interviews of customers, vice presidents, departmental directors, middle management, and general staff. The results of the interviews indicated that XYZ would realize significant business benefits via process redesigns. However, these benefits could not be attained without a common vision of how the business would operate and a business that was prepared to make the change.

The team also determined that the current processes and infrastructure could not efficiently support the requirements of increased customer demands following recent business expansion and acquisitions as well as implementing internal growth strategies. To enable the recommended processes to be successful, a new ERP solution was required, since it was key to obtaining the benefits associated with the redesign. The recommended solution consisted of the following elements:

1. XYZ decided to implement the following modules of SAP Enterprise Resource Planning software:
  - Materials Management,
  - Sales and Distribution,
  - Production Planning,
  - Warehouse Management,
  - Human Resources,
  - Business to Business,
  - Advanced Planning Optimizer (Forecasting Tool),
  - Financial Accounting/Controlling,
  - Costing, and
  - Customer Relations Management.

2. XYZ hired consultants from IBM to help with the implementation process. The ERP system was implemented in early 2002 in order to allow XYZ to enter data into the system and test the system before “go live” which was scheduled for July 2002.

The month of July was chosen because it has historically been a relatively slow period for XYZ’s operations, allowing sufficient time and resource capacity buffers for the SAP implementation project. As “go live” date approached, XYZ’s Information Systems and SAP staff, who had performed transactions within a testing environment in the SAP ERP system, wrote procedures. A “Day in the Life” simulation was run in late May 2002. The SAP systems live production environment was turned on for one day and phony manufacturing orders were entered into the system to simulate an actual day of work. Then the data that the system generated was studied for error and corrective action was taken wherever necessary.

The transition to a new system occurred in July 2002. There was a state of confusion and the Production and Inventory Control department, as well as the SAP help desk, and IS department were pummeled with a lot of questions. The disturbance is expected to have a significant effect for several months. After “go live” the following six major obstacles to a smooth SAP system implementation were been identified:

1. There was a lack of tools for generating necessary reports/ the new system wasn’t customized to the business and everyone fumbled to find some way to measure their progresses,
2. There was a lack of knowledge regarding the forecasting module and no back-up plan as well an unacceptable consultant turnover,
3. Data had been overlooked and wasn’t entered into the system causing many errors,
4. The integrity of some of the data entered into the system was poor, once again causing costly errors,
5. There was a lack of time necessary to successfully implement the project. Management pushed for a quick transition to a new system to save money on current system software licenses,
6. Since “go live” XYZ has been making sure that their process goals are in line with the business goals, by setting proper priorities for each process and putting disciplinary measure in place. They have also identified four main implementation issues:
  - Always develop back up strategies and computer infrastructure systems,
  - Review and understand your current processes and need before defining the need for a system (Choose or design a system around your business needs,)
  - Support and drive from executive staff is a must, and

- Training, Training, Training.

We emphasize that training is a critical condition for a successful implementation. The author has witnessed many employees at XYZ having difficulty with utilizing the features of the new system because of a lack of adequate user training program. It is not that the training everyone received was poor, but by the time the system actually went live, most employees forgot what they were supposed to do. Refresher courses were available, but not mandatory, and the reality of the learning curve effect was recognized the hard way.

The early period of the system implementation was plagued with system problems as well as employee mistakes. The consultant turnover was very significant, resulting in a loss of a personal relationship and user confidence that took time to build. Just when one of the consultants was beginning to bring some light to some of the problems, he/she would be reassigned. This is especially evident in regard to the forecasting tool, which is still to generate relatively accurate and usable forecasts to date.

This crisis was partially part of the consulting firm’s plan to keep staff onsite at XYZ for as long as possible (at \$200 per consultant, per day). In addition to the turnover, I learned that the consultants were very tight-lipped about teaching valuable information to XYZ’s support staff, thus prolonging their stay even longer while XYZ’s support staff scrambled to learn what they could. Furthermore, none of this was communicated to upper management for fear that there would be an even bigger slap on the informant’s wrist. Everyone tiptoed around and no one was willing to upset the norm for fear of scrutiny and/or demotion. This is reflective of XYZ’s traditional top-down corporate culture and reflective of the consulting firm’s questionable business ethics. In the end, when project deadlines passed, SAP implementation progress ground to a halt, and the smoke cleared there were an abundance of XYZ executives pointing their fingers at one another.

In order for XYZ to maximize ROI from SAP implementation, they have institute strong leadership that will reinvent the corporate culture, while promoting an increase in data measurement tools, data integrity, and employee knowledge of the system.

### 3. Conclusions and Recommendations

Following Mark Smith, a co-founder of Partners for Change, there are three elements that must be managed in order for an organization to realize more benefit from an ERP implementation [6].

1. The first element is to develop an exploitation strategy. This is primarily concerned with identifying projects that utilize the base infrastructure and deliver the biggest benefits. The challenge is finding people who understand the business and its processes, understand the technology and can identify quickly where a business can change and

improve performance. The types of projects that are emerging in developing these exploitation strategies include:

- Reengineering around existing installed modules,
- Installation of new modules,
- Use of 'new dimension products' from ERP suppliers, or complementary software from niche suppliers, to get more from customer relationship management, supply-chain management, and information management, and
- Internet applications linked to ERP to open up new sales channels or fundamentally change the nature of the business,

The portfolio needs to be shaped into a program that factors in the need for upgrades and the availability of key resources within the organization.

2. The second element is the development of benefit-focused implementation plans. Developing plans that respond to the benefit opportunities available will demand the involvement of the business in identifying the potential changes that could be made and developing business requirements that will underpin those changes. The resulting plan will be more focused on activities that ensure that the business stays involved and to ensure that the changes are made.

The most critical component of this element is the development of detailed business cases. In the past it has been easy to get projects through the investment net on relatively flimsy business cases. This should not be allowed to continue and involving the right users in the development of the cases builds a sense of ownership in the outcomes.

3. The third element is the establishment of recognizable benefit delivery processes, which have been virtually non-existent around ERP projects. A formal process is required that is initiated as part of the development of the business cases and ends well after the systems and processes go live.

At an early stage, the benefits need to be well articulated and evaluated. Accountability for their delivery needs to be clearly allocated and communicated. This accountability often needs to be shared to reflect dependencies on other functions or processes and these dependencies need to be clear so that people do not wriggle out of their commitments at a later date.

Sustaining mechanisms need to be developed, e.g. inclusion of the expected results in budgets or performance measures. Having these results included in a manager's compensation arrangements is a particularly compelling technique.

Around the build-up to going live it is easy to lose sight of the original purpose of the project: it's benefit. Providing the support mechanisms around and after going live are therefore critical to retain

focus on overcoming the inevitable dip in performance after going live, ramping up to a stabilized performance level as fast as possible and then going forward to delivery of the expected benefit. Installing the sustaining performance monitoring mechanisms to encourage continuous improvement also contributes to building a culture of benefit delivery. This helps enormously, as there will always be the next project in the exploitation strategy to manage" [6].

### 3.1. Aligning and Optimizing Processes: Change Management

Additionally, organizations implementing ERP systems should focus on achieving alignment of the organizational team and scope goals. The organization needs to understand why the project is worth the pain of change. Strategic, tangible business benefits should be spelled out and ways to measure success must be well defined and understood throughout organizational ranks. Top management must be firmly and actively united behind the business goals driving the implementation. With adequate direction, the project could be much more successful because potentially resistant employees can change into project pushers.

The purpose of organizational alignment is to align people, work group structures, and the cultural environment with the business flows that are defined from the business case vision and functional design. This is done to enable the organization and the employees to optimize and leverage the ERP system and its supporting processes. This discipline is the key integration point for the teams who design the business processes and configure the systems. Through this discipline, the change management team obtains a deep knowledge of the business processes, which is essential in order to support the change process in a way that will add tangible value to the organization.

The results of an annual CIO survey performed by Deloitte & Touche Consulting in 1998 point to the need for heavy investment in the area of change management. In this survey, one of the questions the executives were asked was what were the major barriers to the successful implementation of a reengineering program. Out of the top 10 issues listed, only the last one pertains to technology; the others relate to cost to people and change management. People and organizational issues were also identified at the top of the list of factors that contribute most to the success of change.

A recent survey of 259 executives in major U.S. corporations conducted by the American Management Association demonstrated a low level of success for all aspects of the change management effort in their organizations. Executives were asked to rate the importance of various aspects of the change management in terms of the success of change initiatives. They were also asked about how successful their firms have been in

actually dealing with these aspects. The results demonstrated the poor performance of change management programs within these corporations. The results show that top management rates the importance of its own role in change initiatives much higher than their actual rate of successful implementation. When asked to pin point the primary reasons why some or all aspects of change management were not successful, respondents most often cited a lack of sufficient attention to and understanding of, change management issues.

Far too often, the change management and training elements are downgraded to the final stages of the project life cycle. For some companies they are even considered low priorities. Nevertheless, research shows that a typical ERP project ends up spending approximately 35% of its overall budget on change management and training.

One of the most challenging responsibilities for any ERP program lies in dealing effectively with the alignment of people, processes, and systems. This can be achieved through a solid change management framework. Strong business ownership is one component of a solid change management plan. It involves having a leadership role assigned for the implementation. It ensures support for the program vision throughout the organization, by enabling the business to support the change at all levels with an active and visible leadership network. It also includes a process for managing the involvement, communications, and commitment of key leaders. Finally, it includes coaching managers and supervisors to better handle employee resistance during the various phases of the change adoption process.

It is also critical that the change management framework provides a combination of predefined processes, which are planned, managed, and measured. Business ownership is a critical success factor for the program; and the change management processes will achieve their goals only if they are “owned” or strategically directed and overseen by the organization affected.

The process ownership structure is linked with specific processes and functions across all business units. It is composed of decision-makers who are responsible for cross-functional processes. The objective is to translate the program vision into new business processes and supported ERP functionalities.

### 3.2. Nuts and Bolts System Solutions

Preventive measures can be taken with respect to the “nuts and bolts” of an ERP system. These measures are considered solutions since they are reducing the likelihood of problems ensuing later on. Some preventative measures that can boost ROI are as follows:

- When selecting a vendor, assess what impact its applications will have on the company’s existing network,

- Work with the vendor to perform a technical audit to help ensure that the company’s database platform will run smoothly with the ERP solution that is chosen,
- Experiment with the data-conversion utilities available in the new ERP system to discover problems early,
- Once it is determined that the utilities are adequate, convert data from the old system early and often,
- Consider the scalability (or storage space of the system) necessary to maintain business. Calculate storage per employee and don’t settle for any less than is needed,

### 3.3. High-Quality Training

Finally, as noted in some of the companies ERP implementations, training is a top priority, and it can’t be left to only to the IT department to carry out. Training resources should have two components: those allocated for IT personnel and those for end users. IT staff must be trained in the technical aspects of the software and how it will interface with the network. They need to understand both their immediate jobs as they pertain to the ERP system and how those jobs affect everyone else. In a well-run implementation, the ERP vendor and its partners train the IT staff directly and the company doesn’t skimp on training the IT staff: allocating at least 4 percent of the total ERP investment to training. Rather than training the end-user employees on the full range of the ERP system’s capabilities, the curriculum should focus only on those modules the employees will use. In addition, it should address employees’ varied skill levels and provide an overview of the system prior to focusing on the specialized functions needed for their jobs [2].

Additionally any training plan should build in post implementation training costs. Refresher courses as well as a training center are two fundamental assets for companies to obtain in order to promote success before, during and after implementation.

### References

- [1] Benoit, G., “The Winds of Change,” *CMA Management*, 2001, 75(8), 34.
- [2] Ferrando, T., “Training Employees to Use ERP Systems,” *American City & Country*, 2001, 116(14), 12.
- [3] Hayes, D. C., “Market Reactions to ERP Implementation Announcements,” *Journal of Information Systems*, 2001, 15(1), 3.
- [4] Romeo, J., “Less Pain, More Gain in ERP Rollouts,” *Network Computing*, 1997, 12(19), 49.
- [5] Rooney, C., “Is an ERP System Right for You?” *Adhesives Age*, 2000, 43(9), 30.

[6] Smith, M., "Realising the Benefits from Investment in ERP," *Management Accounting: Magazine for Chartered Management*, 1999, 77(10), 34.

# A Single Item Lot Sizing with Backorder and a Finite Replenishment Rate in MRP

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## Abstract

There are the following characteristics in decision on lot size in material requirements planning (MRP) systems: multiple time periods, a finite time horizon, discrete demand, and time-varying costs etc. In MRP system there are several different types of lot size techniques, such as the economic order quantity (EOQ), lot-for-lot, periodic order quantity, Wagner-Whitin algorithm, Silver-Meal algorithm and part-period algorithm. Although these lot size approaches focus on controlling the cost of holding cost and order cost, none of them, with the exception of the Wagner-Whitin algorithm, assures an optimal or minimum cost solution for time-varying demand patterns and copes with quantity discount. And Zangwill(1966), Blackburn and Kunreuther (1974) et al extended the Wagner-Whitin algorithm by following demand to go unsatisfied during some period, provided it is satisfied eventually by production in some subsequent period. R. M. Hill (1997), Stanislaw Bylka, Ryszarda Rempala (2001) give dynamic programming formulation to decide lot sizing for a finite rate input process. But the Wagner-Whitin algorithm and its extensions commonly are criticized as being difficult to explain and compute because the algorithms are complicated dynamic programming algorithms. In this paper, we propose a series of inventory models in which backorder and a finite replenishment rate are considered according to the characteristics in MRP ordering and the optimal solutions can be obtained by using general-purpose linear program solver, like EXCEL, LINDO, etc.

## 1. Introduction

It is important to decide the order quantities in the MRP system. MRP ordering has the features such as multiple time periods, finite time horizon, time-varying costs according to the time periods, and discrete demand, etc. There are two research directions to this practical problem: one is the expansion of the classic inventory theory, such as EOQ model; the other gives models or algorithms directly from the characteristics of the MRP system.

The first research direction focus on how to exceed

the two basic hypotheses: fixed cost and infinite time horizon. In recent thirty years, many researches expanded the application of economic order quantity equation by exceeding one or both of the two basic hypotheses. In 1972, Schwarz [17] suggested a model of EOQ with fixed cost and finite demand horizon. In 1967, 1982, 1985, B. Lev, Taylor [19] etc. presented respectively the EOQ inventory model with one cost change and two time horizons. B. Lev [11] concluded the results of former researches systematically and built a fluctuant EOQ model with one cost change (increase or decrease) and two time horizons (one finite time horizon adding one finite or infinite time horizon) in 1989. In 1990, B. Lev and Zhang Jian [22] discussed the problem of EOQ inventory problem with the permission of two cost changes and three equal finite time horizons. And in 1997 Zhang Jian [23] discussed the same problems with multiple time periods and multiple cost changes. Some of these papers also discussed the backorder inventory problem in certain degree, and had important effect on the development of inventory theory. But some of the assumptions such as continuous demand made in regard to classical inventory models (economic order quantity (EOQ), economic production quantity (EPQ), and economic order interval (EOI)) are inappropriate for demand that varies from period to period. In this direction, the EOQ used in MRP ordering is to ignore the variation and apply the EOQ formulation with an average demand rate. The indiscriminate use of these methods can result in larger than necessary inventory costs for these conditions [15].

The other research direction began with a different approach provided by Manne [14] and by Wagner and Whitin [21] in 1958; they divided time into discrete periods and assumed that the demand in each period is known in advance. Since 1958, the Manne-Wagner-Whitin model has received considerable attention, and several hundred papers have directly or indirectly discussed this model; most of these papers have either extended this model or provided efficient algorithms for production problems that arise in it. The references given here and those given by Bahl, Ritzman and Gupta [1] provide only some of the papers related to the Manne-Wagner-Whitin model. Today, even an introductory operations research textbook is likely to

include a chapter on the Manne-Wagner -Whitin model and on some of its extensions (See, for example, Johnson and Montgomery 1974 [10], Wagner 1975 [20], Denardo 1982 [4], Richard J. Terine. 1988 [15], and Hax and Candea 1984 [8]). Because of the immense interest in economic lot size models, a considerable amount of research effort has been focused on establishing the computational complexity of various economic lot size problems. (In particular, see Florian, Lenstra and Rinnooy Kan 1980 [6], Bitran and Yanasse 1982 [2], Luss 1982 [13], Erickson, Monma and Veinott 1987 [5], and Chung and Lin 1988 [3]). As the extensions of Wagner-Whitin algorithm, Zangwill(1966), Blackburn and Kunreuther (1974) et al extended the Wagner-Whitin algorithm by allowing demand to go unsatisfied during some period, provided it is satisfied eventually by production in some subsequent period [18]. R. M. Hill (1997) [16], Stanislaw Bylka, Ryszarda Rempala (2001) [21] give dynamic programming formulation to decide lot sizing for a finite rate input process. But the Wagner-Whitin algorithm and its extensions commonly are criticized as being difficult to explain and compute because the algorithms are complicated dynamic programming algorithms. And many other non-optimal algorithms, such as lot-for-lot, periodic order quantity, Silver-Meal algorithm and part-period algorithm occurred [15, p161-178].

In this paper, we proposed the model that can obtain the economic lot size in MRP ordering systems with backorder and a finite replenishment rate. Then, we transfer the model into linear programming, and deduce three other models, i.e., the model considering a finite time rate, the model considering backorder and the model in which backorder is prohibited and an infinite replenishment rate. Finally, to illustrate the proposed models we give a numerical example.

The models proposed in the paper permit order cost, holding cost, backorder cost, price break points, and item prices varying from period to period. Comparing with the Wagner-Whitin algorithm and its extensions, the models are easier to explain and compute because the models are linearized or linear models and the optimal solutions of them can be obtained easily by using general-purpose linear program solver, like EXCEL, LINDO, etc.

## 2. Mathematical model of the backorder and finite replenishment rate

Assumption:

The planning horizon is finite and composed of several time periods.

The demand is known and occurs at the beginning of each period, but may change from one period from another.

Lead-time is fixed.

Each time period is characterized by finite replenishment rate, which may be caused by a fixed

production capacity or supply capacity from vendors and any interrupt between the replenishment incur setup cost.

The order quantity may not satisfy the demand in time, and the shortages or stockouts are considered. But stockout in the end of the time horizon is prohibited.

Items requirements in a period are withdrawn from inventory at the beginning of the period. Thus, the holding cost is applied to the end-of-period inventory and is only applied to inventory held from one period to the next. Items consumed during a period incur no holding cost.

MRP is a rolling schedule and projected on hand being not zero is considered.

Suppose that there are I periods in MRP system, we introduce the following problem parameters:

$i=\{1, \dots, I\}$ , the index set of periods,

$R_i$  = requirements in units for period  $i$ ,

$OC_i$  = fixed ordering cost or setup cost per order for period  $i$ ,

$HC_i$  = holding cost per unit for period  $i$ ,

$BC_i$  = backorder cost of an item for period  $i$ ,

$S_0$  = stock on hand for period 1 start or for period 0 end,

$M$  = a sufficiently large number.

$P_i$  = replenishment quantity if the replenishment for the whole period  $i$  is continued.

Decision Variables

$X_i$  = whether start to order or not (0-1 variables) for the  $i$ th period,

$Y_i$  = whether to replenish or not (0-1 variables) for the  $i$ th period,

$Q_i$  = lot size or replenish quantity for the  $i$ th period.

$Z_i$  = whether backorder or not (0-1 variables) for period  $i$ .

The problem, denoted by RBP, is to solve:

Problem BDP:

Minimize  $TC =$

$$\sum_{i=1}^I S_0 + \sum_{j=1}^i (Q_j - R_j) [(1 - Z_i) \cdot HC_i - Z_i \cdot BC_i] + \sum_{i=1}^I X_i \cdot OC_i + \sum_{i=1}^I P \cdot Q_i \quad (1)$$

Subject to

$$S_0 + \sum_{i=1}^I (Q_i - R_i) \geq 0 \quad (2)$$

$$S_0 + \sum_{j=1}^i (Q_j - R_j) \leq M \cdot (1 - Z_i) \quad i=1,2,\dots,I, \quad (3)$$

$$S_0 + \sum_{j=1}^i (Q_j - R_j) \geq -M \cdot Z_i \quad i=1,2,\dots,I. \quad (4)$$

$$Q_i \leq P_i \cdot Y_i \quad i=1, 2 \dots I \quad (5)$$

$$X_i = Y_i \quad (6)$$

$$Y_i - Y_{i-1} \leq M \cdot X_i \quad i=2, 3 \dots I \quad (7)$$

$$Q_i \geq P_i - M \cdot (1 - Y_{i+1}) - M \cdot (1 - Y_i) \quad i=1, 2 \dots I-1 \quad (8)$$

In BDP, the objective function, i.e. equation (1) is to minimize the total inventory cost which include holding cost and backorder cost over I time periods, i.e.

$$\sum_{i=1}^I S_0 + \sum_{j=1}^i (Q_j - R_j) [(1-Z_i) \cdot HC_i - Z_i \cdot BC_i], \text{ ordering}$$

cost, i.e.,  $\sum_{i=1}^I X_i \cdot OC_i$ , and item purchase cost, i.e.,

$$\sum_{i=1}^I P \cdot Q_i.$$

Equation (2) denotes any backorder should be fulfilled in the end of Ith period end. When  $S_0 + \sum_{j=1}^i \sum_{u=0}^U Q_{uj} - R_j \geq 0$  stands for plus stock level for period, i.e.,  $Z_i = 0$  can be obtained from equation (3). And in the other case  $Z_i = 1$  from equation (4). Equation (5) means that replenish happen i.e.,  $Y_i = 1$  when  $0 < Q_i < P_i$  for period i and vice versa. For the time period 1,  $Y_1 = 1$  then  $X_1 = 1$  and vice versa which determined by equation (6) and for the period i (i=1, 2, ..., I), the order start to occur for period I i.e.,  $X_i = 1$  if  $Y_i - Y_{i-1} = 1$  and vice versa which is shown in equation (7). Equation (8) mean that replenish quantity  $Q_i$  for period i should be  $Q_i = P_i$  if the replenishment continue through the full period i.

### 3. Discussion on RBP

In the model RBP, it is difficult to calculate the optimal economic replenish quantity since equation (1) is nonlinear. Here, in order to resolve this problem easily we introduce two kinds of nonnegative variables:

$BQ_i$  = the quantity of backorder for period i,

$HQ_i$  = the quantity of inventory for period i.

Then model RBP can be improved as linear programming model, denoted by LRBP is:

Problem LRBP:

$$\begin{aligned} \text{Minimize } TC = & \sum_{i=1}^I BQ_i \cdot BC_i + \sum_{i=1}^I HQ_i \cdot HC_i + \sum_{i=1}^I X_i \cdot OC_i \\ & + \sum_{i=1}^I P \cdot Q_i \end{aligned} \quad (9)$$

Subject to

$$S_0 + \sum_{j=1}^i (Q_j - R_j) \geq 0 \quad (10)$$

$$HQ_i - S_0 + \sum_{j=1}^i (Q_j - R_j) \leq M \cdot Z_i \quad i=1,2,\dots,I, \quad (11)$$

$$HQ_i - S_0 + \sum_{j=1}^i (Q_j - R_j) \geq -M \cdot Z_i \quad i=1,2,\dots,I, \quad (12)$$

$$BQ_i + S_0 + \sum_{j=1}^i (Q_j - R_j) \leq M \cdot (1 - Z_i) \quad i=1,2,\dots,I, \quad (13)$$

$$BQ_i + S_0 + \sum_{j=1}^i (Q_j - R_j) \geq M \cdot (Z_i - 1) \quad i=1,2,\dots,I, \quad (14)$$

$$Q_i \leq P_i \cdot Y_i \quad i=1,2,\dots,I, \quad (15)$$

$$X_i = Y_i \quad i=1,2,\dots,I, \quad (16)$$

$$Y_i - Y_{i-1} \leq M \cdot X_i \quad i=1,2,\dots,I, \quad (17)$$

$$Q_i \geq P_i - M \cdot (1 - Y_{i+1}) - M \cdot (1 - Y_i) \quad i=1,2,\dots,I, \quad (18)$$

Here we explain the equations (11)-(14). When  $Z_i = 0$ , equations (11) and (12) are binding and equivalent to

$$HQ_i = S_0 + \sum_{j=1}^i \sum_{u=0}^U Q_{uj} - R_j > 0. \quad \text{Otherwise } Z_i = 0,$$

equations (13) and (14) are binding and equivalent to

$$BQ_i = -S_0 + \sum_{j=1}^i \sum_{u=0}^U Q_{uj} - R_j > 0.$$

In model BDP, suppose backorder is not permitted in MRP ordering system, i.e.,  $Z_i = 0$ , then

$$\begin{aligned} & \sum_{i=1}^I S_0 + \sum_{j=1}^i \sum_{u=0}^U Q_{uj} - R_j [(1-Z_i) \cdot HC_i - Z_i \cdot BC_i] \\ = & \sum_{i=1}^I S_0 + \sum_{j=1}^i \sum_{u=0}^U Q_{uj} - R_j \cdot HC_i \end{aligned} \text{ in equation (1) and}$$

equations (2), (3) and (4) are equivalent to the constraint

$$S_0 + \sum_{j=1}^i \sum_{u=0}^U Q_{uj} - R_j \geq 0 \quad (i=1,2,\dots,I). \text{ The model RBP}$$

or model LRBP will become a the model of finite replenishment problem, denoted by RP, is:

Problem RP:

$$\begin{aligned} \text{Minimize } & TC \\ = & \sum_{i=1}^I HQ_i \cdot HC_i + \sum_{i=1}^I X_i \cdot OC_i + \sum_{i=1}^I P \cdot Q_i \end{aligned} \quad (19)$$

$$S_0 + \sum_{j=1}^i (Q_j - R_j) \geq 0 \quad i=1,2,\dots,I \quad (20)$$

$$Q_i \leq P_i \cdot Y_i \quad i=1,2,\dots,I, \quad (21)$$

$$X_i = Y_i \quad i=1,2,\dots,I, \quad (22)$$

$$Y_i - Y_{i-1} \leq M \cdot X_i \quad i=1,2,\dots,I, \quad (23)$$

$$Q_i \geq P_i - M \cdot (1 - Y_{i+1}) - M \cdot (1 - Y_i) \quad i=1,2,\dots,I, \quad (24)$$

In model LRBP, suppose the entire order is received into inventory at one time in MRP ordering system. Equations (21)----(24) are equivalent to  $Q_i \leq M \cdot X_i$   $i=1,2,\dots,I$ . Then model LRBP become a backordered problem, denoted by BP, is:

Problem BP:

$$\text{Minimize } TC = \sum_{i=1}^I BQ_i \cdot BC_i + \sum_{i=1}^I HQ_i \cdot HC_i + \sum_{i=1}^I X_i \cdot OC_i + \sum_{i=1}^I Q_i \cdot P_i \quad (25)$$

Subject to

$$S_0 + \sum_{i=1}^I (Q_i - R_i) \geq 0 \quad (26)$$

$$HQ_i - \left[ S_0 + \sum_{j=1}^i (Q_j - R_j) \right] \leq M \cdot Z_i \quad i=1,2,\dots,I, \quad (27)$$

$$HQ_i - \left[ S_0 + \sum_{j=1}^i (Q_j - R_j) \right] \geq -M \cdot Z_i \quad i=1,2,\dots,I, \quad (28)$$

$$BQ_i + \left[ S_0 + \sum_{j=1}^i (Q_j - R_j) \right] \leq M \cdot (1 - Z_i) \quad i=1,2,\dots,I, \quad (29)$$

$$BQ_i + \left[ S_0 + \sum_{j=1}^i (Q_j - R_j) \right] \geq M \cdot (Z_i - 1) \quad i=1,2,\dots,I, \quad (30)$$

$$Q_i \leq M \cdot X_i \quad i=1,2,\dots,I, \quad (31)$$

In model RBP, suppose backorder both are not permitted and the entire order is received into inventory at one time in MRP ordering system. From the analysis in model BP and RP, the model with no permission of backorder and simultaneous replenishment, denoted by P, is:

Problem P:

$$\text{Minimize } TC = \sum_{i=1}^I \left[ S_0 + \sum_{j=1}^i (Q_j - R_j) \right] \cdot SC_i + \sum_{i=1}^I OC_i \cdot X_i + \sum_{i=1}^I P_i \cdot Q_i \quad (32)$$

Subject to

$$S_0 + \sum_{j=1}^i (Q_j - R_j) \geq 0 \quad i=1,2,\dots,I, \quad (33)$$

$$Q_i \leq M \cdot X_i \quad i=1,2,\dots,I, \quad (34)$$

#### 4. Numerical Example

A item has a unit purchase price of \$5, an ordering cost per order of \$100, a unit holding cost per week of \$1, replenishment rate per period of 60 units and a unit backorder cost per week of \$2. Project on hand at period 1 start is 35 units and lead-time for the item is zero. Determine the replenish quantities for each week by model BDP from the requirements in table 1.

By using model LRBP we get the results in table 2.

Table 1 Gross requirements

Period (week)	1	2	3	4	5	6	7	8	9	10
Gross requirements	35	30	40	0	10	40	30	0	30	55

Table 2 The optimized MRP net requirements plan

Period (week)	0	1	2	3	4	5	6	7	8	9	10	Total cost (\$)
Gross requirements	-	35	30	40	0	10	40	30	0	30	55	-
Project on hand	35	0	30	0	0	0	10	0	0	30	0	-
Backorder quantity	-	0	0	0	0	10	0	0	0	0	0	-
Net requirements	-	0	30	10	0	10	50	20	0	30	25	-
Planned-order receipt	-	0	60	10	0	0	60	20	0	60	25	-
Holding cost (\$)	-	0	30	0	0	0	10	0	0	30	0	70
Ordering cost (\$)	-	0	100	0	0	0	100	0	0	100	0	300
Backorder cost (\$)	-	0	0	0	0	20	0	0	0	0	0	20
Total cost* (\$)	-	0	130	0	0	20	110	0	0	130	0	390

\*Here item cost is not considered since the unit purchase price does not change with the time periods, which will not be mentioned in the following tables.

Table 3 The MRP net requirements plan when the backorder cost is \$0.5

Period (week)	0	1	2	3	4	5	6	7	8	9	10	Total cost (\$)
Gross requirements	-	35	30	40	0	10	40	30	0	30	55	-
Project on hand	35	0	0	0	10	0	0	0	0	20	0	-
Backorder quantity	-	0	30	10	0	0	40	70	10	0	0	-
Net requirements	-	0	30	70	10	0	40	70	70	40	35	-
Planned-order receipt	-	0	0	60	20	0	0	0	60	60	35	-
Holding cost (\$)	-	0	0	0	10	0	0	0	0	20	0	30
Ordering cost (\$)	-	0	0	100	0	0	0	0	100	0	0	200
Backorder cost (\$)	-	0	15	5	0	0	20	35	5	0	0	80
Total cost (\$)	-	0	15	105	10	0	20	35	105	20	0	310

In Table 2, the finite replenishment rate i.e., 60 makes that the replenishment quantity for each time can't be replenished in one week, e. g. in the 2<sup>nd</sup> week requirements of 70 units satisfied by 60 units in the 2<sup>nd</sup> week and 10 units in the 3<sup>rd</sup> week. The total cost is \$390.

Decreasing the replenishment rate per week to \$0.5, the results are shown in Table 3.

Comparing Table 3 with Table 2, we can find some changes when the backorder cost per week per unit reduces from \$2 to \$0.5. Apparently, the times of backorder increases from 1 to 5 times and order times from 3 times to 2 times. That causes the order costs changing from \$300 to \$200, the backorder cost rising from \$70 to \$80 and the holding cost decreasing from \$70 to \$30. The total cost decreases \$80 according to the above changes.

By changing the backorder cost per unit per week, we could get Figure 1.

In Figure 1, the total cost has the increase trend with the rising backorder cost per unit per week. When the backorder cost is zero, MRP system will keep the backorder status, ordering all the 235 units in the last four periods by 60 replenishment rate per week, order cost occurring only one time and holding cost being zero. When the backorder is higher than \$3, backorder becomes uneconomic. The MRP system is equals to the system without backorder i.e., the computing results are same between model LRBP and model RP.

Decreasing the replenishment rate per week from 60 units to 70 units, we get the net requirements plan showed as Table 4.

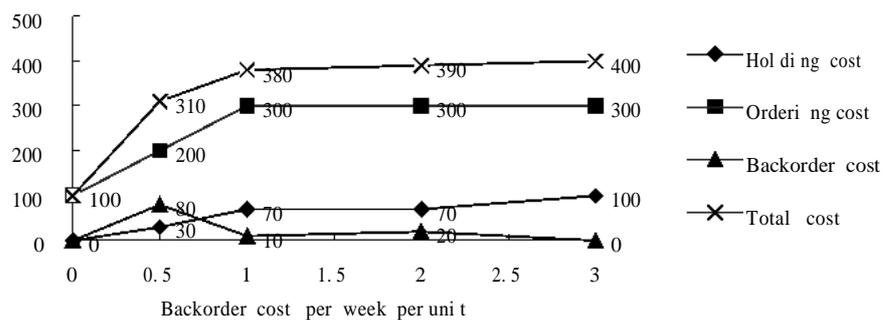


Figure 1 Cost variance with backorder cost per week per unit changing

Table 4 The Optimized MRP net requirements plan when the replenishment quantity per period is 70 units

Period (week)	0	1	2	3	4	5	6	7	8	9	10	Total cost (\$)
Gross requirements	-	35	30	40	0	10	40	30	0	30	55	-
Project on hand	35	0	40	0	0	0	20	0	0	40	0	-
Backorder quantity	-	0	0	0	0	10	0	0	0	0	0	-
Net requirements	-	0	30	0	0	10	50	10	0	30	15	-
Planned-order receipt	-	0	70	0	0	0	70	10	0	70	15	-
Holding cost (\$)	-	0	40	0	0	0	20	0	0	40	0	100
Ordering cost (\$)	-	0	100	0	0	0	100	0	0	100	0	300
Backorder cost (\$)	-	0	0	0	0	20	0	0	0	0	0	20
Total cost (\$)	-	0	140	0	0	20	120	0	0	140	0	420

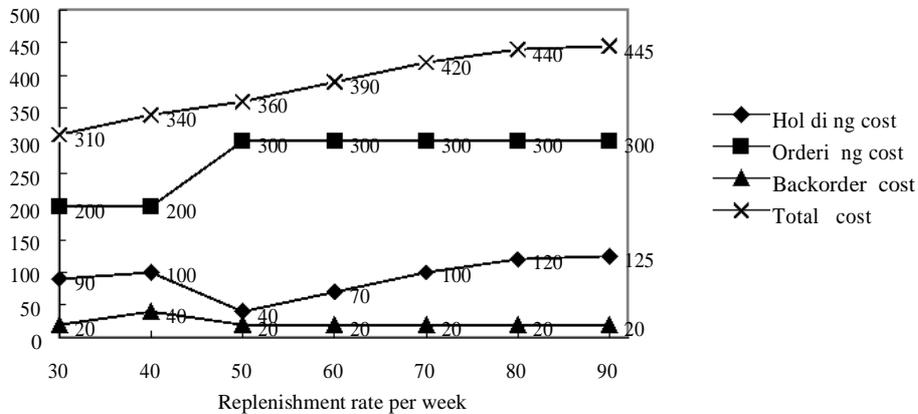


Figure 2 Cost variance with replenishment rate per week changing

From Table 2 and Table 4, when the replenishment rate per week is increased from 60 units to 70 units, only the holding cost enhanced from \$70 to \$100 and the total cost increase to \$420.

By changing the replenishment rate per week, we get Figure 3.

From Figure 2, the total cost rise with the increase of the replenishment rate per week. But since the replenishment rate per week is fixed, when the replenishment rate per week is too lower e.g. 40 units, the MRP system must replenish inventory in the most of the weeks for fear that the requirements can't be replenishment at the end of the 10<sup>th</sup> week and makes the holding cost rise correspondingly. And when the replenishment rate per week is too high e.g. 90 units, the replenishment quantity for each time is fulfilled in a week and the results obtained from model BP and model LBRP are same.

## 5. Concluding remarks

In this paper, firstly we proposed the general model

RBP that can obtain the economic lot size in MRP ordering systems with backorder and a finite replenishment rate. Secondly, the nonlinear programming model RBP is transferred into linear one, and deduces three other models, i.e., the model RP considering a finite replenishment rate, the model BP considering backorder and the model P with no permission of backorder and simultaneous replenishment. Finally, to illustrate the models proposed we give a numerical example. The models proposed can be adapted to such by dynamic change using the idea of rolling horizon, especially in MRP ordering.

However, there are several limitations in the proposed models and research directions as follows.

1) The models proposed assume that all information is known with certainty and is static throughout the planning horizon. This is not always the case, especially when it comes to demand forecasts, since usually a demand realization is not likely to be different from the forecast of that demand.

2) All of the approaches proposed in this paper seek to minimize costs for a single item and do not consider

items as part of a multistage inventory system across the planning horizon; to be specific, none examines the impact of lot size at a higher level in a production structure upon lower items.

3) Aside from the limitation of a finite replenishment rate, a budget that limits the amount of investment in inventory and a warehouse capacity restricting available storage space often confront managers. The model will have more application value if it can combine MRP net requirement plan with CRP (capacity requirements planning) considering these constraints.

4) The lead time in this paper is fixed and quantity discounts is not considered in our model. However, either lead time or item price may change with the order quantities even at the same time point.

## References

- [1] Bahl, H. C., L.R. Ritzman, J. N. D. Gupta. Determining Lot Sizes and Resource Requirements: A Review. *Opns.Res.* 35, 329-245, 1987.
- [2] Bitran, G.R., H. H. Yanasse. Computational Complexity of the Capacitated Lot Size Problem. *Mgmt. Sci.* 28,1174-1186, 1982.
- [3] Chung, C. -S., C. -H. M. Lin. An  $O(T^2)$  Algorithm for NI/G/NI/ND Capacitated Lot Size Problem. *Mgmt. Sci.* 34, 420-426, 1988.
- [4] Denardo, E. V. *Dynamic Programming: Models and Applications*. Prentice-Hall, Englewood Cliffs, N. J, 1982.
- [5] Erickson, R. E., C. L. Monma, A.F. Veinott, Jr. Send-and-Split Method for Minimum-Concave-Cost Network Flows. *Math. Opns. Res.* 12, 634-664, 1987.
- [6] Florian, M., J. K. Lenstra, A. H. G. Rinnaay Kan. Deterministic Production Planning: Algorithms and Complexity. *Mgmt. Sci.* 26, 669-679, 1980.
- [7] Hadley G, Whitin TM. *Analysis of inventory Systems*. Englewood Cliffs, NJ: Prentice-Hall, 1963.
- [8] Hax, A. C., D.Candea. *Production and Inventory Management*. Prentice-Hall, Englewood Cliffs, N. J, 1984.
- [9] Jay Heizer, Barry Render. *Production and Operations Management*, Forth Edition . Prentice Hall, 1999.
- [10] Johnson, L. A., D. C. Montgomery. *Operations Research in Production Planning Scheduling, and Inventory Control*. John Wiley, New York, 1974.
- [11] Lev B, Weiss H. J. Inventory Models with Cost Changes. *Opns. Res.*, 38(1): 53~634, 1989.
- [12] LI Nai-xiong. Inventory models and optimal replenishment policies for a kind of materials. *Journal of Guangxi University of Technology*. Vol.11 No.2 Mar., 5-7, 2000.
- [13] Luss, H. Operations Research and Capacity Expansion Problems; A Survey. *Opns. Res.* 30, 907-947, 1982.
- [14] Manne, A. S. Programming of Economic Lot Sizes. *Mgmt. Sci.* 4, 115-135, 1958.
- [15] Richard J. Terine. *Principles of Inventory and Materials Decision*, Third Edition. North-Holland.91-281, 1988.
- [16] R. M. Hill. Note: Dynamic lot sizing for a finite rate input process. *Naval Research Logistics Quarterly* 44, 221-228, 1997.
- [17] Schwarz L B. Economic Order Quantities for Products with Finite Demand Horizons. *AIIE Trans*, 4:234-236, 1972.
- [18] Stanislaw Bylka, Ryszarda Rempala. Multiproduct lot sizing for finite production rate. *International Journal of Production Economics*. 305-315, 2001.
- [19] Taylor SG, Brandley C E. Optimal Ordering Strategies for Announced Price Increases. *Opns.Res.*, 33(2):102-113, 1985.
- [20] Wagner, H. M. *Principles Of Operations Research, With Applications to Managerial Decisions*, 2nd ed. Prentice-Hall, Englewood Cliffs, N. J, 1975.
- [21] Wagner, H. M., T. M. Whitin. Dynamic version of the Economic Lot Size Model. *Mgmt. Sci.*5, 89-96, 1958.
- [22] Zhang Jian, Lev B. Three Equal Period Inventory Model with Cost Changes. *Proceedings of TIMS-XXX*, Providence, USA,203-211, 1990.
- [23] Zhang Jian. Optimization for One of Multiple Time Period EOQ Inventory Policies with Cost Changes. *Journal of Systems Engineering*. Vol.12 No.11, 1997.

# ERP is the Key Point of Supply Chain Management

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## Abstract

Information technology is changing the mode of customer service, material purchasing, price making in an enterprise. To keep advantage, an enterprise has to take supply chain management. By sharing information and making plans together, an enterprise and its providers, its customers, can improve their whole logistic efficiency through supply chain management. ERP is classic of information management in modern enterprises. ERP manages and controls effectively every node of supply chain inside an enterprise. It's the information flat on which an enterprise manages and makes decision. It is the key point of supply chain management.

## 1. Introduction

Only when an enterprise take full use of its inside resource, and conform its outside resource, can it keep its sales advantage in the furious competition.

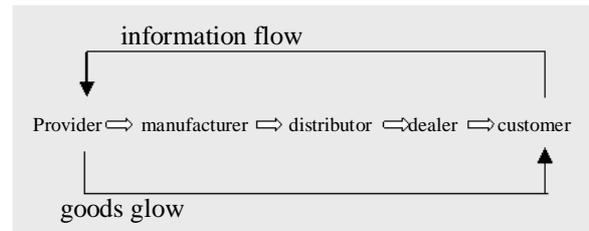
Information technology is changing the mode of client management, material purchasing, price making in an enterprise. Customers now demand to get goods whenever and wherever in the lowest price most quickly. For this, an enterprise has to change its logistics flow, cooperate with its partners (providers, customers) in supply chain management of business affairs.

## 2. The Concept of Supply Chain

The manager of Changan Motor went to Korea for inspection. He saw the motor accessories made in Korea are cheaper than those made in Chongqin, China. If he import the accessories to his company, they cost 40 percent less. But accessories' production and import need a period of time. He don't want to store many accessories, neither does he want the productive speed slowlier. How can the provider in Korea know his company's plan, and supply the accessories on time? This points to the communication and cooperation between two enterprises, not inside an enterprise.

This is a simple case of supply chain management. The concept of supply chain management is, an enterprise and its providers, its customers, are improving their whole logistics efficiency by sharing information and making plans together, by forming a quick responding channel through provider, manufacturer, distributor, retailer and customers.

picture 1 composing of supply chain



Though supply chain management, once the logistics channels that links up several independent enterprises loosely, now manage to work together to improve their whole efficiency and competence. The motive of supply chain is to improve the competence of the logistic channels.

## 3. Supply Chain Management Needs Information Flat to Support

The motivity of supply chain management comes from the request of customers. The goal is quick response, least variance, least inventory and high satisfaction of customers.

Supply chain management emphasizes that an enterprise and its providers, its customers should share information, make plans together and cooperate with others.

Sharing information among enterprises needs information flat to support. Only when information runs in numeric network, can upriver and downriver company get what they need at the first time and make quick response, least variance become possible.

Making plan together can decrease the uncertainty of demand and supply. This makes least inventory, least variance become reality. When an enterprise is making a plan, information flat is required to transfer information that comes from market and strategetic partners. When plans are carried into execution, information flat is required to feedback the variety of demand. So that the enterprise can adjust its plan in time and respond quickly.

## 4. An Efficient Information System of Management Is Required Before Putting Supply Chain Management into Practice

Supply chain management is a reticulation structure formed by many nodes. The adjacent nodes are joined by providing and requirement. They are buckled one by one.

The work of the whole supply chain will be affected whenever a node is in trouble. If the business process of an enterprise is unsuitable, not only the enterprise itself, but the supply chain will work more ineffective.

So we say, the suitable business process and scientific administrant system are required before an enterprise puts supply chain management into practice. If the business process ineffective, the managing troublesome in an enterprise, in the traditional mode, it can be made up for the lost by adjusting the procedure temporarily. Sometimes it won't come to a big lost. But in the mode of supply chain management, enterprises share their resources and restrain the other enterprises. A trouble in an enterprise will enlarge several times into a trouble through the whole supply chain. For example, one day the provider meets a matter. He can't provide raw material on time. Then manufacture will stop without raw material. The manufacturer can't supply goods to the distributor. Then the distributor will have to take a rest because of lack of goods...

This comes to a conclusion. An enterprise should make its business process effective, administrant system scientific by reengineering and standardizing its procedure before supply chain management is put into practice. Further more, the enterprise should ameliorate its inside administrant structure persistently after supply chain management has been carried into execution.

In the supply chain management among a few enterprises, there are goods flow, information flow and capital flow. Supply chain benefits from goods flow mostly. The essential of supply chain is to improve the efficiency of goods flow by the alliance and cooperation among enterprises. It represents as quick response and least inventory. How can we make the goods flow faster, the cost less, deviation smaller? We must depend on the timely and exact information flow. Information flow in the supply chain is what enterprises base on when they make a decision or management. This is to say, information flow is the core of supply chain management. Thus the enterprise with supply chain management must have a data processing system, to collect exact data, analyse the data, organize the data, and support tekecommunications and E-business.

## 5. ERP Is Classic of Information Management in Modern Enterprises

ERP(Enterprise Resource Planning) is a system based on information technology, guided by systemic managing ideology, merged information technology and advanced manage ideology, applied by modern enterprises.

Firstly, ERP is an information system of management guided by modern administrant ideology. The viewpoint of traditional management is to produce right goods and sell them at the right time. The core of ERP is to get the most profit at the right time and on the right place. ERP takes the procedure in an enterprise as a supply chain joined tightly. It divides the enterprise into a few subsystems which cooperate with each other, such as finance system, sales system, manufacture system and else. ERP manages and

controls effectively every node of supply chain inside the enterprise, which includes order, purchase, stock, manufacture, controlling quality, transport and distributing.

With ERP, all information can communicate among departments timely. This ensures the info management and unitary producing. The management and control become more efficient.

Secondly, ERP is correlated with BPR(Business Process Reengineering) tightly. The essential of ERP is sharing resource and cooperation inside an enterprise by using information technology. When ERP is carried into execution, some problems such as the detachment of department management, the difference of managing scale, lots of repeatedly work will be optimized and ameliorated. The amelioration must reengineer the enterprise's business process, information process, and reform the organize. Thus the business process will become more suitable. Producing and managing will become more effective.

Thirdly, ERP is an advanced, systemic data processing system. ERP applies the newest production of computer and communication technology, including GUI, RDBMS, OOT, the fourth language, client/server and DDM. ERP integrates the enterprise's resource and bring the productivity multiplier into effect through information technology. Besides manufacture, purchase, sales, finance, ERP supports storage, transport, OLAP, after service, quality feedback, tekecommunications, E-business, and EDI.

That is to say, ERP is an integrative system of advanced managing ideology, theory and method. ERP integrates the business process and information flow in an enterprise highly. ERP is classic of information management in modern enterprises.

## 6. ERP Is the Key Point of Supply Chain Management

A few national great corporations in our country realize the importance of supply chain management now. Haier, Hisense and Legend are building or have built an automatic, intellectualized modern logistic system which is of international level. But there are still lots of enterprise that don't know what supply chain management is. Neither do they know the status of logistics management abroad. Most enterprises have little information ordinary. They have no information system for management in deed. And their business process is no longer suit the commercial environment and need to be reengineered.

Putting supply chain management into practice is difficult without an effective information system in an enterprise. Supply chain management bases on the cooperation among enterprises. If the management ineffective, amelioration is very complex and hard. However, ERP is an information system of management inside one enterprise. Carrying ERP into execution is easier. Because having a suitable information system and highly integration of managing information, putting supply

chain management into practice is simple with ERP carried out. What needs to do is to decide the symbiosis and duty sharing. ERP will suits the change because it is ameliorating continuous and consummating persistently.

So we can say, ERP is the key point of supply chain management in china. Supply chain management will take full effect only when ERP is carried out. Supply chain management is impossible without ERP.

## 7. Conclusion

The core of logistics in an enterprise is to deliver goods to customers on time and accurately.

supply chain management can enhance the logistic efficiency of an enterprise and ensure the enterprise's sales advantage in the furious competition.

ERP manages every node of supply chain inside an enterprise effectively. It's the information flat on which an enterprise manages and makes decision. It is the key point of supply chain management.

## References

- [1] ChenMing, TangGuoli, ZhangYinkui., "The Developed Tendency Of Modern Enterprises ", Journal of Research Of Enterprises ,Vol. 4, 2002.
- [2] WuJinban,"An Information System Of Logistics And Management In The Enterprise", Journal of Commercial Economy, Vol.10, 2001.
- [3] LiuJian , " From Logistics Management To Supply Chain Comformity ", <http://www.56net.com>.

# A Bi-Directional Approach for Developing Data Warehouses in Public Sectors

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## Abstract

Data warehouse is proclaimed as the latest decision support technology. As data warehouses require a significant amount of organizational resources to develop, more research have been devoted to identifying the critical success factors and the formulas for assured investment return from data warehouses. This study proposes a bi-directional development approach for data warehouses in public sectors. The primary rationale for the proposed approach is the fundamentally different organizational goals of public sector organizations from private sector organizations. Whereas the ultimate goal of private sector organizations is profit making, public sector organizations have a set of conflicting goals including different social and political objectives. The star schema as a dimensional data model for data warehouse is not totally suitable for data warehouses that demand the analyses of both quantitative and qualitative measures. Using the data warehouse in the College of Business Administration at the California State University, Sacramento as a case study, we illustrate how the QQ (Quantitative and Qualitative) data schema accommodates the need of capturing both quantitative and qualitative information. In addition, we show the bi-directional top-down/bottom-up initiative, the formal/informal information collection, and the enterprise data warehouse/subject data mart architecture for the data warehouse.

## 1. Introduction

Inmon [13] defined data warehouse as a subject oriented, integrated, non-volatile, and time variant collection of data for decision support. In the past decade, we have seen the concept and technology of data warehousing evolving from a visionary idea to the mainstream of decision support in corporate culture. It was estimated that the investment in data warehousing will grow from US\$8.8 billion in 1996 to US\$113.5 billion in 2002 [30]. About 85-90% of the Fortune 500 companies have either adopted or plan to adopt data warehouses [25]. The International Data Corporation (1996) reported an average return on investment of 401% in 62 data warehouses, with an average 1.7-year payback period. On the other hand, the failure rate of data warehouses is also very high. While the exact figures are not available, the initial failure rate of data warehouse is estimated to be one-half to two-thirds [31][30]. Following the development path of introduction, proliferation (or growth), control, and maturity, data

warehousing is currently in the stage of proliferation. The accumulation of success and failure experience is generating a wealth of guidance on the application of data warehousing in organizations.

The public sectors are usually slow in adopting new information technology because of their complex organizational structure and project approval process. The past diffusion of information technology follows the path from private sectors to public sectors. In terms of supporting semi-structured or unstructured decision making, the public sectors are as needy as, if not more than, the private sectors. We have seen the application of decision support systems in the areas of resource allocation [15][19][26], admission policies [8], scheduling [9], hazardous waste management [24], and auditing [30]. Data warehousing, the latest development of decision support tools, has been gradually adopted as a problem solver for strategic issues in public sectors. Given the fundamental differences in organizational goals and structure between public and private sectors, the development of data warehouses in public sectors may require different methodologies, tools, and skills. This study attempts to identify the suitable methodology in the planning and design phase of data warehouse in public sectors. The rest of the paper is organized into the following five sections. Section 2 provides a literature review on the data warehousing for the past few years. Section 3 identifies some organizational characteristics in private and public sectors. Section 4 presents the bi-directional approach for developing data warehouses in public sectors. Section 5 illustrates the bi-directional approach using a business school case study. The last section concludes the paper by suggesting some future research directions.

## 2. Data Warehousing in the Literature

Among the seventeen data warehousing research studies we identified from the literature in the past few years, seven are explorative case studies [23][7][21][1][18][25], three are survey studies [6][31][28], three are theoretical analysis without empirical data [20][2][29], two are data warehousing for auditing purposes [11][22], and two are Web-based data warehouses [5][12]. The distribution of our reviewed articles indicates case study as a popular research method in this proliferation stage of data warehouse development. Researchers are observing the development of different data warehouses in different organizations, collecting data about the success and failure factors, accumulating

experience about the planning imperative, design methods, implementation tactics, and operational procedures for data warehouses. We will see the accumulation of case knowledge leading to the development of consolidated theories for the control stage of data warehousing in the coming decade. This section will review some of the recent findings about data warehousing in the literature.

For case studies, Sammon & Finnegan [23] investigated the data warehousing practice of four corporate users. Using semi-structured interviews and document analysis, they identified ten critical success factors for data warehousing. The ten factors are business-driven initiative, executive sponsorship and commitment, funding commitment based on realistically managed expectations, project team with access to cross-functional project management and implementation experience, attention to source data quality, flexible enterprise data model, effective data stewardship, long-term plan for automated data extraction methods and tools, knowledge of data warehouse compatibility with existing systems, and hardware/software proof of concept. Cooper et. al [7] described how the data warehouse technology transformed the First American Corporation from a traditional banking to a customer centric system. The VISION data warehouse at First American Corporation was designed to provide data and analysis to allow the management to know the client better, provide what the client needs, help the client achieve goals, and offer the client preferred channels. First American Corporation managed to re-align the organizational structure with new information technology infrastructure and strategy, which is proved to be a critical factor in enabling the organization to reap benefits from the data warehouse.

Quaddus & Intrapairrot [21] reported the end-user adoption and usage process of data warehouse in the Siam Commercial Bank, a major commercial bank in Thailand. They found that the policies of “increase level of training” and “decrease training delay” can significantly accelerate the diffusion of data warehouse usage. Ang & Teo [1] investigated the data warehouse developed for the Housing and Development Board in Singapore. This is the only case study in public sectors among the seven case studies. The management issues of concern in this case study include identifying the development process, choosing development options, adopting incremental change approach, overcoming resistance, choosing project leader, providing formal and systematic training, and scalability and maintenance. This case study did not focus on developmental differences between private and public sector data warehouses. Marks and Frolick [18] presented the development process of a data warehouse in a home service company. The most important lessons learned from the case study are clear mission, effective business analysis, and top management support. Watson et. al [30] had the question of why some organizations realized

more benefits from data warehouses than others. They traced the development of data warehouses in a large manufacturing company, the Internal Revenue Services, and a financial services company. Their findings show that a successful data warehousing process constitutes the steps of articulating a vision, communicating the vision throughout the organization, and institutionalizing the changes required by the vision. Shin [25] studied the project management issues of a data warehouse project in one of the biggest insurance companies in the US. The study identified the following essential practices for the successful data warehouse project management: (1) process involvement by business units and prospective end-users; (2) manageable project scope; (3) packaged tools for data staging; (4) marketing the new system throughout the project to business customers and target users; and (5) metadata-centric system design and implementation based on conformed dimensions and facts.

For survey studies, Chen et. al [6] developed a questionnaire to investigate the concept of user satisfaction with data warehouses. They identified data accuracy, format, and precision; support provided to end-users; and fulfillment of end-users needs as the three major factors for data warehouse satisfaction. The advice is to provide training and support to end-users, in order for end-users to understand the meaning of data in the data warehouse. Wixom and Watson [31] were interested in the role of implementation in data warehouse success. Their study was a cross-sectional survey from 111 organizations using paired mail questionnaires on implementation factors and success of warehouses. They found that the link between implementation and warehouse success is weak. However, there are significant correlations between data quality and perceived net benefits, and between system quality and perceived net benefits. Watson et al. [28] carried out a survey to explore the topics of sponsorship, architecture, use, costs, and benefits in data warehouse. The 47 usable responses indicate that about 40% of data warehouses were sponsored by vice-president of a business unit, 36% were used in marketing and sales, 32% were of data warehouse only architecture; 58% of the surveyed organizations had an average number of 18.5 users in the information system units, 52% had an average number of 150.5 users in the marketing and sales unit, 41% had an average number of 48.4 users in the finance units, 43% used a prototype approach to develop data warehouses; and 66% of the end-users believed that the data warehouses met their objectives.

Another research direction in data warehouse is to develop theoretical models to describe, explain, and predict the generic phenomenon of data warehousing. Murtaza [20] presented a framework for developing enterprise data warehouses. The framework consists of the stages of business requirements, data sourcing, target architecture, access tool selection, and administration. Ballou & Tayi [2] constructed an integer programming

model to maximize the total value from all projects for improving the data quality in data warehouse environments. The model considers the factors of current data quality, required data quality, anticipated data quality, priority of organization activity, cost of data quality enhancement, and the utility of value added from data improvement projects. Watson et. al [29] described the benchmark variables including data, architecture, stability of the production environment, warehouse staff, users, impact on users' skills and jobs, applications, costs and benefits, and organizational impact for the stages of initiation, growth, and maturity in data warehousing. There are other specific research topics such as incorporating the Web elements into data warehousing [5][12] and the role of data warehouses in auditing [11][22].

The above review of the data warehouse literature in the past few years shows that only a few studies [1][11] have investigated the role of data warehouses in public sectors. It is the purpose of this study to develop an appropriate development approach for data warehouses in public sectors.

### **3. Organizational Characteristics in Private and Public Sectors**

Table 1 summarizes the relevant organizational characteristics for data warehouse development in private and public sectors. One important difference is the organizational goals. Private sector organizations have the ultimate goal of making profit, which can be translated into increasing the share values of investors. On the other hand, public sector organizations (such as federal and state agencies, public educational institutes, and charity organizations) are non profit making, and have multiple social and political objectives. In other words, private sector organizations' goals can be readily quantified whereas public sector organizations' goals have to be measured both qualitatively and quantitatively.

Another difference is the organizational structure. Private sector organizations tend to have clear lines of authorities and responsibilities. Since the goal of profit-making is quantifiable, it is easier to pinpoint the problematic areas when the organizations cannot meet the goals. The numbers speak for themselves showing whether the sales departments do not make enough revenue, the production departments over-spend on raw materials, or the marketing departments do not reach enough potential buyers. If the current structure is not contributive to profit making, private sector organizations are more willing to change the structure. Since structural change is permissible, it is less likely for private sector organizations to rely on informal structure to work around problems. On the other hand, since public sector organizations have to achieve multiple or conflicting objectives, the structure is designed to have a check and balance effect. The lines of authorities and responsibilities are more likely to be overlapping and

vaguely defined. The obscure lines of responsibilities make it difficult to trace the contributions of different organizational units to the organizational goals, which further make it difficult to justify any structural changes for improving organizational effectiveness. As it is difficult to have structural change, ineffectiveness and inefficiencies may be ignored or solved by informal working structure.

As for management style, any styles that can promote profit making will usually be encouraged in private sector organizations. Public sector organizations tend to have management styles that balance different social and political objectives. People who achieve managerial or leadership positions in public sector organizations have very good diplomatic skills but they are reluctant to give commitment and be change agents. As for the working personnel, private sector organizations motivate employees by relatively well-defined monetary reward systems. Private sector employees know very well what they have to do in order to be rewarded. In public sector organizations, personnel are more likely to work by the books in order to avoid being blamed. The reward systems are usually determined by and distributed over different authorities such as the labor union and a multi-level set of ruling units. Public sector employees are in a worse position than their private sector counterpart to control their career destinies. As for change management, since private sector organizations have more competitors, they tend to have more environmental sensors to detect threats and opportunities. They tend to have more formalized systems to respond to crises and carry out required changes. Private sector organizations, on the other hand, usually avoid changes unless they are mandated by top management or their survivals are threatened. In summary, public sectors organizations have quantitative and qualitative objectives, overlapping and vague lines of responsibilities and authorities, top management focusing on balancing, working personnel focusing on maintenance, and intrinsic persistence on status quo. These relative characteristics affect the application process of data warehousing technology. The next section discusses a bi-directional approach for developing data warehouses in public sectors.

### **4. A Bi-Directional Development Approach for Data Warehouses in Public Sectors**

The literature suggests different system development life cycles for data warehouses [17][16][10][4][27][3], and most include the stages of initiation, information requirement, architecture design, data sources, data modeling, end-user interface, implementation, testing, training, and maintenance. Each step has its own methodology, tools, and skills. The bi-directional development approach for data warehouse proposed in this study focuses on the stages of initiative, information requirement, architecture design, and data modeling. Figure 1 summarizes the suggestions of the bi-directional

approach for data warehouse development in public sectors.

For the initiative stage, the bi-directional approach suggests the simultaneous top-down and bottom-up for planning and justification of data warehouses. The hybrid approach can reduce the strong opposition to changes in public sector organizations. The bottom-up direction may be triggered by end-users' dissatisfaction with the current level of information quality and information processing procedure. The top-down direction may be stimulated by external forces that threaten the survival, legitimacy, or status of the organization. The congruency of the two directions provides a fertile ground for data warehouse success. If the data warehouse initiative is mandated by top management without support by end-users, the data warehouse adoption process will be difficult to diffuse. To the extreme, the end-users may sabotage the data warehouse. A data warehouse proposed solely by end-users may not be able to get the multi-level top management's attention in highly bureaucratic public sectors.

For the information requirement stage, the bi-directional approach suggests both the formal and informal channels for requirement identification. As public sector organizations have informal structure performing significant tasks, it is important to collect information requirements from informal channels. Formal channels include interviews, on-site observations, analyses of reports, tables, manuals, and other published strategic papers. Informal channels are unrecorded complaints, grievances, hidden agendas, personal contacts, gossips, and casual discussions.

For the stage of architecture design, the bi-directional approach recommends a combined architecture of enterprise data warehouse and data mart. A pure enterprise data warehouse approach develops one and only one comprehensive data warehouse to support all decision activities in all departments for the organization. A pure data mart approach develops many independent and small data warehouses supporting different organizational units or decision subjects. Given the multiple and conflicting objectives in public sector organizations, the pure data mart approach will not be able to give an overall view of the organizational truth to leaders performing balancing acts. On the other hand, the pure enterprise data warehouse will be too time consuming and complicated to build. The combined approach will first generate a high-level blueprint for the enterprise level data warehouse, then set the priorities for different data marts, and build the most visible, least risky, and most valuable data mart as a proof of concept project. This bi-directional approach has the effect of building the data warehouse incrementally without losing sight of how the data mart pieces will fit together as a seamless entity.

For the stage of data modeling, the bi-directional approach proposes a new data modeling technique QQ schema (first Q for quantitative and second Q for qualitative), capturing both quantitative and qualitative bottom line measures for public sector organizations. The star schema as a dimensional data model for data warehouses [17] is designed to store quantitative data such as sales figures, costs, and budget variances in the center fact table surrounding by multiple dimension tables. Any qualitative data have to be stored in dimension tables, which are used as headers and sub-headers in multidimensional analyses and reports. Once data are stored in dimension tables, they cannot be sliced and diced as in the fact table because dimension tables are usually not inter-related. Given that public sector organizations are not purely figure-driven, it is important to have both qualitative and quantitative measures in the tables that support strategic and tactical analyses. The next section will illustrate the bi-directional development approach using a case study for a business school data warehouse.

## **5. A Case Study Illustrating the Bi-Directional Development Approach for Data Warehouse**

This section describes the data warehousing experience at the College of Business Administration (CBA), California State University at Sacramento (CSUS) in the United States. The data warehouse project started in the Fall of 2001 and is on-going. The CBA at CSUS has about 130 full-time and part-time faculty members, 4000 undergraduate students, and 380 graduate students in Fall 2001. The CBA has four academic departments including Accountancy, Management, Management Information Science, and Organizational Behavior and Environment.

### **5.1 Top-down and bottom-up initiative for data warehouse**

The CBA at CSUS received her re-accreditation from AACSB International (The Association to Advance Collegiate Schools of Business, formerly American Assembly of Collegiate Schools of Business) a few years ago. Amongst the turmoil of leadership transitions from 1995 to 1997, the CBA managed to collect her efforts, engage her faculty members, address issues of AACSB concerns, and finally earned the re-accreditation. The re-accreditation process has taught the administration and faculty members who were involved in the process a lesson of the critical role of information under the new AACSB accreditation guidelines.

Under the California State University System, faculty members have to submit activity reports for the purposes of salary merit increase, tenure and promotion, and post-tenure review. The re-accreditation process also required faculty members to fill in questionnaires for

satisfaction and curriculum surveys, as well as submit faculty data sheets listing their intellectual contributions and professional activities. In total, a faculty member can be requested to submit up to 5 different reports in one year. Many reports have overlapping data that can be consolidated. Faculty members expressed their frustration over filling in multiple reports for the same information. The administration also felt the painful process of collecting data from different sources to satisfy different information requests from the AACSB and other external bodies. In Spring 2001, the Academic Office of the University announced funding availability that was earmarked for strategic information technology and requested proposal for the funding. One proposal for a data warehouse project was submitted from the Management Information Science Department. The Dean of the CBA gladly and enthusiastically approved the data warehouse proposal. The initiative process of the CBA data warehouse is bi-directional, supported by end-users and endorsed by top management.

## 5.2 Formal and informal information requirements

The CBA Dean and the principal investigator of the data warehouse project compiled a list of interviewees for identifying information requirements. The interviewee list included all department heads, all CBA institute directors, the chairperson of Academic Council, the directors of undergraduate and graduate programs offices, and other key decision makers in the College. The question list consisted of the following items:

- i. What tasks in your job involve decision making? What tasks do you need to perform in order to support your immediate supervisor's decision making activities?
- ii. Which tasks you identified in question 1 have very important effect on your overall job performance?
- iii. Do you feel that you have or can obtain enough, timely, and relevant information to carry out the tasks you identified in question 1?
- iv. If your answer to question 3 is no, what other information do you need?
- v. If your answer to question 3 is no, how would you like to improve the information acquisition methods?
- vi. Do you feel that you have enough analysis methods to carry out the tasks you identified in question 1?
- vii. If your answer to question 6 is no, what other analysis methods do you need?
- viii. Do you feel that the current decision making process for the tasks in question 1 is efficient and effective?

- ix. If your answer to question 8 is no, how would like to improve the decision making process?

The information collection process took about three months. There are two factors that facilitated the information collection process. First, being a faculty member and involved in the re-accreditation process, the principal investigator has first-hand knowledge about the information needs of the college. Second, the principal investigator's peer status to the interviewees certainly enhances the trust and open communication during the information collection process. In many occasions, after going through all the formal questions, informal discussions added a lot of insightful requirements to the data warehouse. For example, one department head supported the data warehouse wholeheartedly because it can level the information grounds for all decision makers. That department head had the concern of being unable to access data directly and carry out analyses. Since data can be manipulated and presented in a certain way to support a certain proposition, having access to the same data allows other decision makers to verify the analyses or to present alternative analysis results. The same organizational truth from a data warehouse can streamline the data collection process and avoid locally optimized decisions. The above concern makes it important to allow decision makers to build their customized reports, in addition to pre-defined system reports for general purposes. The information collection process for the CBA data warehouse has been benefited from both the formal and informal channels.

## 5.3 Data warehouse and data mart architecture

The information collection process identified three major subjects for data warehouses, namely, faculty, students, and alumni. For each subject, there are various decision making activities to support. The subject faculty was determined to have the highest priority for implementation. The development strategy is to launch one data mart with high visibility and return as soon as possible, in order to generate confidence from end-users and top management. However, the conceptual blueprint for the enterprise data warehouse will be finished before the first data mart implementation. This is to ensure that the design of each data mart can be consolidated together into the enterprise data warehouse. Individual data marts need to have the suitable conformed dimensions serving as the overlapping tables across different fact tables. Though conformed dimensions can be added later, it will be less disruptive to the warehouse operations if they are built-in rather than added-back. The concurrent design for data warehouse and data marts can produce faster result but not at the expense of losing the overall data warehouse requirements.

## 5.4 Quantitative and qualitative (QQ) data schema

Figure 2 presents a partial QQ data schema for the faculty subject data mart for the CBA data warehouse.

The center of the data schema has two fact tables, one for numbers and the other for text, which are essential information to keep track of for faculty. Surrounding the fact tables are dimension tables including faculty, publication/professional organization, and time. The attribute *CategoryID* representing the classification of each record i.e., instructional development, applied scholarship, basic scholarship, or consulting activities in the Qualitative Fact Table. The relationship cardinality between the two fact tables is (0,\*) and (1,\*) meaning that one record from the qualitative table is associated with 1 or many records from the quantitative table; and one record from the quantitative table is associated with 0 or many records from the qualitative table. The QQ data schema is proposed in this project to support the storage and manipulation of both quantitative and qualitative measures.

## 6. Conclusion

This study proposes a bi-directional approach for data warehouse development in public sectors. The approach focuses on the stages of initiative, information requirement, architecture design, and data modeling for the development process. The initiative stage combines the top-down and bottom-up directions. The information requirement utilizes both formal and informal channels. The architecture design adopts both enterprise data warehouse and subject data marts. The data modeling extends the star schema to capture both qualitative and quantitative measures for organizations that are not purely profit-driven. The bi-directional approach was illustrated using a case study in the College of Business Administration at the California State University, Sacramento. The data warehouse at CBA has been benefited from the bi-directional approach. The data warehouse project is on-going and we expect to expand and fine-tune the bi-directional approach as more experience is accumulated in the future.

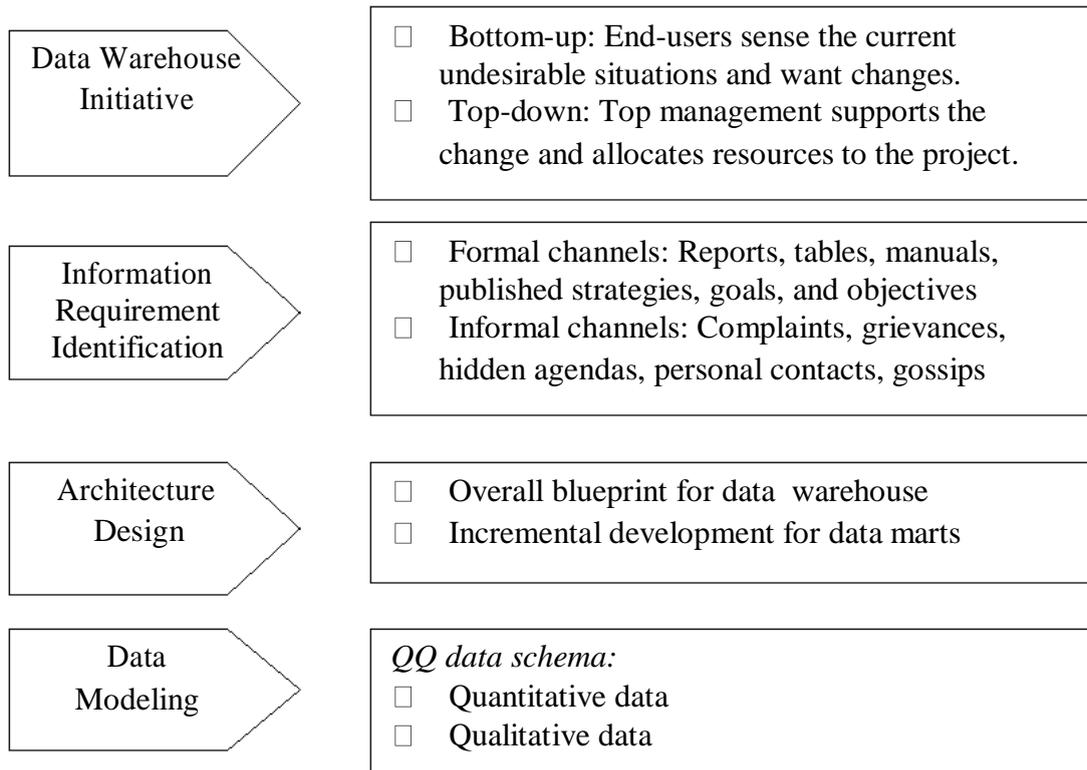
## References

- [1] Ang, J., Teo, T. S. H. (2000). Management issues in data warehousing: insights from the housing and development board. *Decision Support Systems*, 29, 11-20.
- [2] Ballou, D. P., & Yayi, G. K. (1999). Enhancing data quality in data warehouse environments. *Communications of the ACM*, 42:1, 73-78.
- [3] Barquin, R. C., & Edelstein, H. A. (eds.). (1997). *Planning and Designing the data Warehouse*. Prentice Hall PTR.
- [4] Bischoff, J., & Alemander, T. (1997). *Data Warehouse: Practical Advice from the Expert*. Prentice Hall.
- [5] Chen, L. D., & Frolick, M. N. (2000). Web-based data warehousing. *Information Systems Management*, 17(2), 80-86.
- [6] Chen, L. D., Soliman, K. S., Mao, E., & Frolick, M. N. (2000). Measuring user satisfaction with data warehouses: an exploratory study. *Information & Management*, 37, 103-110.
- [7] Cooper, B. L., Waston, H. J., Wixom, B. H., & Goodhue, D. L. (2000). Data warehousing supports corporate strategy at First American Corporation. *MIS Quarterly*, 24(4), 547-567.
- [8] Elimam, A. A. (1991). A decision support system for university admission policies. *European Journal of Operational Research*, 50, 140-156.
- [9] Foulds, L. R., & Johnson, D. G. (2000). Slotmanager: a microcomputer-based decision support system for university timetabling. *Decision Support Systems*, 27, 367-381.
- [10] Gill, H. S., & Rao, P. C. (1996). *The Official Guide to Data Warehousing*. Que.
- [11] Granof, M. H. (1999). Governmental accounting and reporting: a data warehousing approach. *The Government Accountants Journal*, 48(2), 30-38.
- [12] Huang, Z., Chen, L. D., & Frolick, M. N. (2002). Integrating web-based data into a data warehouse. *Information Systems Management*, 19(1), 23-34.
- [13] Inmon, W. H. (1996). *Building the Data Warehouse*. Wiley Computer Publishing.
- [14] International Data Corporation. (1996). *Financial Impact of Data Warehousing*. IDG.
- [15] Kwak, N. K., & Lee, C. (1998). A multicriteria decision-making approach to university resource allocations and information infrastructure planning. *European Journal of Operational Research*, 110, 234-242.
- [16] Kimball, R. (1996). *The Data Warehouse Toolkit: Practical techniques for Building Dimensional Data Warehouses*. John Wiley & Sons, Inc.
- [17] Kimball, R., Reeves, L., Ross, M., & Thornthwaite, W. (1998). *The Data Warehouse Lifecycle Toolkit*. Wiley Computer Publishing.
- [18] Marks, W. T., & Frolick, M. N. (2001). Building customer data warehouses from a marketing and service environment: a case study. *Information Systems Management*, 18(3), 51-56.
- [19] Milton-Smith J., Schmidberg, O., & Klass, D. (1999). Strategic planning, strategic goals and group decision support systems: a business school case study. *International Journal on Technology Management*, 17(1/2), 173-194.
- [20] Murtaza, A. H. (1998). A framework for developing enterprise data warehouses. *Information Systems Management*, 15(4), 21-26.
- [21] Quaddus, M., & Intraparirot, A. (2001). Management policies and the diffusion of data warehouse: a case study using system dynamics-based decision support system. *Decision Support Systems*, 31, 223-240.
- [22] Rezaee, Z., Sharbatoghlie, A., Elam, R., & McMickle, P. L. (2002). Continuous auditing: building automated auditing capability. *Auditing*, 21(1), 147-163.
- [23] Sammon, D., Finnegan, P. (2000). The ten commandments of data warehousing. *The Data Base for Advances in Information Systems*, 31(4), 82-91.
- [24] Sen, T. K., Moore, L. J., & Hess, T. J. (2000). An organizational decision support system for managing the DOE hazardous waste cleanup program. *Decision Support Systems*, 29, 89-109.
- [25] Shin, B. (2002). A case of data warehousing project management. *Information & Management*, 39, 581-592.
- [26] Tyagi, R., Moore, L. J., & Taylor, B. W. III. (1988). A decision support system for funds management in a public university. *Operations Research*, 36(6), 864-881.
- [27] Vidette, P., Klauer, P., & Brobst, S. (1998). *Building a Data Warehouse for Decision Support*. Prentice Hall PTR.
- [28] Watson, H. J., Annino, D., Wixom, B. H., Avery, K. L., & Rutherford, M. (2001a). Current practices in data

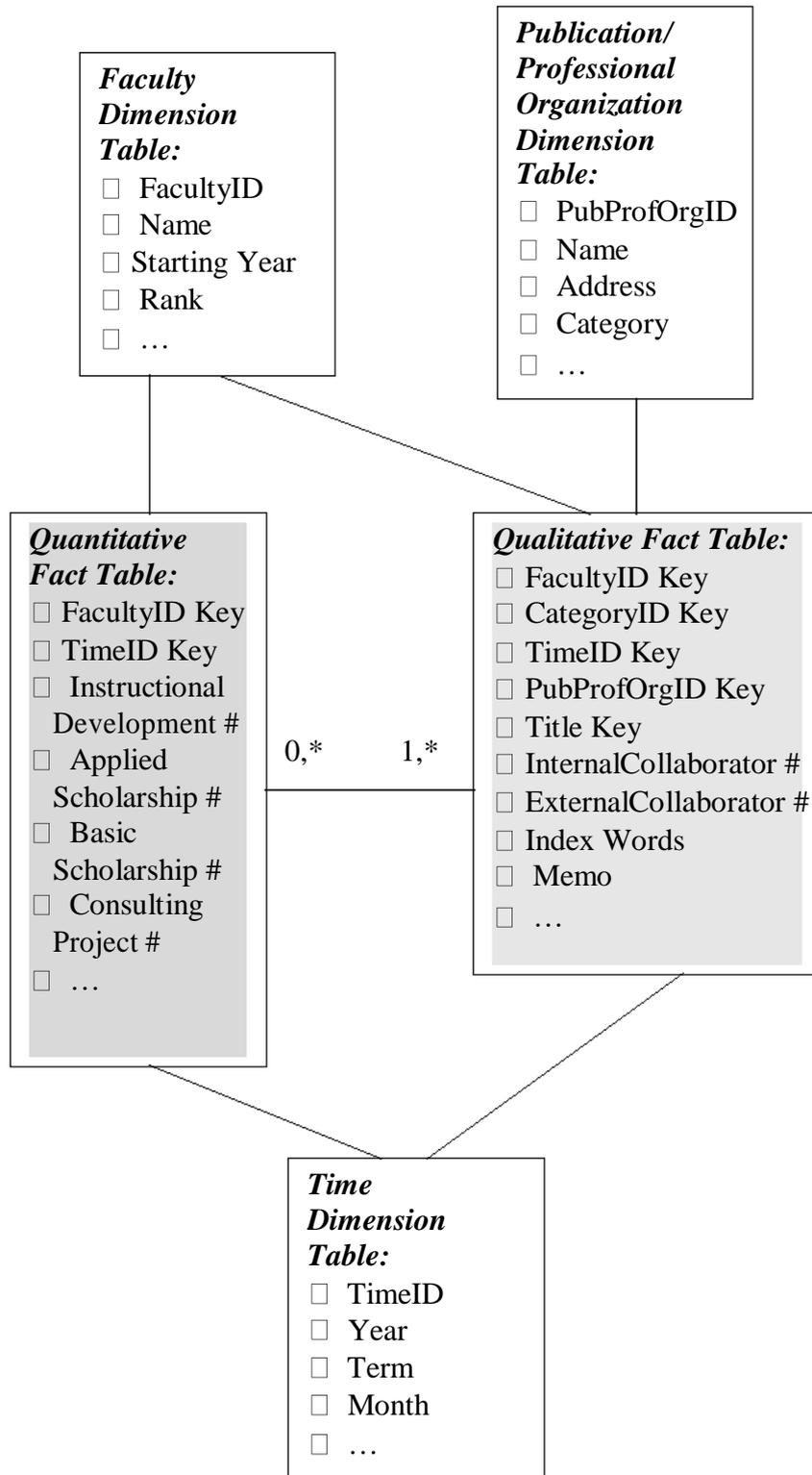
- warehousing. *Information Systems Management*, 18(1), 47-55.
- [29] Watson, H., Ariyahandra, T., & Matyska, R. J. Jr. (2001b). Data warehousing stages of growth. *Information Systems Management*, 18(3), 42-56.
- [30] Watson, H. J., Goodhue, D. L., & Wixom, B. H. (2002). The benefits of data warehousing: Why some organizations realize exceptional payoffs? *Information & Management*, 39, 491-502.
- [31] Wixom, B., & Watson, H. J. (2001). An empirical investigation of the factors affecting data warehousing success. *MIS Quarterly*, 25:1, 17-41.

**Table 1 Organizational Characteristics in Public and Private Sectors**

	<b>Private Sectors</b>	<b>Public Sectors</b>
<b>Organizational Goal</b>	<input type="checkbox"/> Profit making as the most important goal	<input type="checkbox"/> Non-profit making <input type="checkbox"/> Multi-objectives <input type="checkbox"/> Political and social values
<b>Organizational Structure</b>	<input type="checkbox"/> Clear line of responsibility and authority <input type="checkbox"/> Less informal structure <input type="checkbox"/> Easier to change structure and replace personnel	<input type="checkbox"/> More overlapping and redundant line of responsibility and authority <input type="checkbox"/> More informal structure <input type="checkbox"/> More difficult to correct structural problems
<b>Management Style</b>	<input type="checkbox"/> Promote the style that can improve profit	<input type="checkbox"/> Emphasize on the diplomatic style that can balance different political and social values
<b>Personnel</b>	<input type="checkbox"/> Motivated by clearly-defined monetary reward systems <input type="checkbox"/> Responsibilities well defined and understood	<input type="checkbox"/> Motivated by avoiding being blamed <input type="checkbox"/> Reward and responsibility systems not clearly defined
<b>Change Management</b>	<input type="checkbox"/> Use more environmental sensors <input type="checkbox"/> More likely to have a formal plan for change <input type="checkbox"/> Drastic changes and measures possible	<input type="checkbox"/> Less willing to change unless imposed by top management or survival is threatened <input type="checkbox"/> More difficult to have drastic changes and measures



**Figure 1 Bi-Directional Approach for DW Development in Public Sectors**



**Figure 2 The QQ Data Schema – Faculty Subject**

# Query Optimization Techniques for OLAP Applications: An ORACLE versus MS-SQL Server Comparative Study

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## Abstract

Query optimization in OLAP applications is a novel problem. A lot of research was introduced in the area of optimizing query performance, however great deal of research focused on OLTP applications rather than OLAP. In order to reach the output results OLAP queries extensively asks the database, inefficient processing of those queries will have its negative impact on the performance and may make the results useless. Techniques for optimizing queries include memory caching, indexing, hardware solutions, and physical database storage. Oracle and MS SQL Server both offer OLAP optimization techniques, the paper will review both packages' approaches and then proposes a query optimization strategy for OLAP applications. The proposed strategy is based on use of the following four ingredients: 1- intermediate queries; 2- indexes both B-Trees and Bitmaps; 3- memory cache (for the syntax of the query) and secondary storage cache (for the result data set); and 4- the physical database storage (i.e. binary storage model) accompanied by its hardware solution.

**Keywords:** query optimization, OLAP, caching, indexing, MS SQL Server, Oracle.

## 1. Introduction to query optimization

Query Optimization (QO) is a process the success of which affects the entire database (DB) performance [15]. There are basically two types of DB:

1. Archival DB e.g. data warehouse (DW) that is primarily used for query retrievals;
2. Transactional DB e.g. Online Transaction Processing (OLTP) that is primarily used for data maintenance i.e. insert, update, and delete operations.

Efficient QO strategy is a major task in the archival DB types. When a DBMS parses a query it decides the best plan (i.e. strategy) to execute it based on statistics it retains about DB structure, indexes, and number of distinct values. Query optimizer is that part of DBMS that decides which query plan is the best [15]. Relational systems offer the users access to data via high-level

language and it's the responsibility of the system to select efficient plans to execute queries called query evaluation plans (qeps) [6].

## 2. Query optimization mechanisms

There are many query optimization mechanisms. The mechanisms fall into two main categories: hardware (H/W) and software (S/W). *Following is a description of both:*

### 1. The H/W mechanisms:

Currently DB servers make extensive use of multiple processors. DB servers use symmetric multi-processor (SMP) or massive parallel processor (MPP) technology [20]. Some database Management Systems (DBMS) make use of these technologies. DBMS break down a query into parts and process them in parallel by different processors. The most common approach for that is by replicating the query so each copy works against portion of the DB which is usually horizontally partitioned [15] [20]. The same query is to run on each portion in parallel in a separate processor then intermediate results are combined to create the final query set as if the query was running once on the entire DB. A study by [20] reported that the query time was cut by 50% by using parallel processing compared to a table scan ( $T = TW/P$ ; where T is time, TW is table scan time, and P number of processors). The same study [20] indicated that creating an index using parallel processing was reduced to 5 seconds from nearly 7 minutes.

### 2. The S/W mechanisms:

Indexing the DB is one of the best and cheapest methods for improving performance. An index is a data structure that represents a column stored in a certain order [7]. DB optimizers scan the appropriate index to identify any target rows faster than scanning the entire table. If the table is indexed, a binary search for files is carried out on the blocks rather than on the records. A binary search usually accesses  $\log_2(b)$  blocks which is considered an improvement over linear search that is on average accesses  $(b/2)$  blocks when found or b blocks if not found [9]. Caching and physical storage are other two

mechanisms through which queries could be optimized [5] [11] [23].

### 3. Foundations and assumptions

A DB consists of a number of relations. A relation  $R$  contains attributes  $att_1, att_2, \dots, att_n$ .  $R$  is a subset of the Cartesian product  $dom(att_1) \times dom(att_2) \times \dots \times dom(att_n)$ , where  $dom(att_j)$  is a set of values for  $att_j$ . A tuple  $t$  is an ordered list of attribute values which has an associated unique identifier ( $t\_id$ ). An expression  $e$  is used to derive relations and is defined as a group of predicates on some attributes [5]. The length of an expression is the number of attributes involved in the expression. Expressions of length equals 1 are called elementary expressions. For example, an expression of length 2 is like the following:

$\langle price \in [100,200] \wedge type = 'local' \rangle$

An expression  $e_{sub}$  is a sub expression of  $e$  if each elementary expression of  $e_{sub}$  is included in  $e$  and  $length(e) > length(e_{sub})$ . An expression  $e'$  is an extension of  $e$  if  $e$  is a sub expression of  $e'$  and  $length(e') - length(e) = 1$ . An expression  $e'$  is a reduction of  $e$  if  $e'$  is a sub expression of  $e$  and  $length(e) - length(e') = 1$ . An expression  $e'$  is a neighbor of  $e$  if  $e'$  is an extension of  $e$  or  $e'$  is a reduction of  $e$ . A generalization enlarges the range of an elementary expression, whilst a specialization reduces the range of an elementary expression [5].

### 4. Previous work and the research gap

[1] Introduced their query optimization mediator system on which they made no difference between OLTP and OLAP applications. Their contribution resulted in a caching mechanism that allows use of query results of previous queries in case the source is not readily available.

[5] Implemented a framework for query optimization to support data mining applications. The framework proposed concentrated on two main factors; search strategies (hill climber, simulated annealing, and genetic algorithms), and physical DB design.

[6] Proposed a framework for processing a sequence of interdependent queries for which a multi-query optimization is required. Their optimization plan includes: determining on the basis of the dependencies between queries which order they should be specified and which results should we store, then each query is passed separately to the DB optimizer.

[11] Suggested a generalized projections (GP) query optimization technique. GP captures aggregations, group by, projections with duplicate elimination, and duplicate preserving projections. The GP pushes down query trees for select-project-join queries which use any aggregate function. The pushing down technique will result in the removal of tuples and attributes early and consequently

leading to smaller intermediate relations and reducing the query cost.

[23] Focused on optimizing selection queries using Bitmaps. For static query optimization, divide the selection into continuous and discrete ones and suggested algorithms for evaluating discrete selections using bit-sliced indexes including time and space constraints.

Reviewing the previous research work-up to our knowledge- indicates that no efforts have been exerted to introduce QO strategy for OLAP applications. The main contribution of this paper is in proposing a novel QO strategy which will focus mainly on supporting OLAP applications.

### 5. On Line Analytical Processing (OLAP)

Although relational database management systems (RDBMS) are powerful solutions for a wide range of commercial and scientific applications, they are not designed to address the multidimensional information requirements of the modern business analyst, for example forecasting, and classification [3].

The key driver for the development of OLAP is to enable the multi-dimensional analysis [19]. Although all the required information can be formulated using relational database and accessed via SQL, the two dimensional relational model of data and SQL have some serious limitations for investigating complex real world problems. Also slow response time and SQL functionality are a source of problems [3]. OLAP is a continuous and iterative process; an analyst can drill down to see much more details and then he can obtain answers to complex questions.

OLAP represents the use of a set of graphical tools that provides users with multidimensional views of their data and permits them to analyze the data by utilizing simple windowing techniques [15]. OLAP refers to DSS and EIS computing applications [22].

Whilst multidimensionality is the core of a number of OLAP systems available [19], there is a list of elements that determine which OLAP product to purchase:

1. *Multidimensional conceptual view*. The tool must support users with the level of dimensionality needed to enable the required analysis to be carried out;
2. *Transparency*. The heterogeneity of input data sources should be transparent to the users to prevent their productivity decreasing;
3. *Accessibility*. The OLAP system should only access the data required for analysis;
4. *Consistent reporting performance*. As the number of dimensions increases and the database size grows, users will expect the same level of performance;
5. *Client/Server architecture*. The OLAP system has to be compatible with the client/server architectural principles;

6. *Generic dimensionality*. Every data dimension should be in both its structure and operational capabilities;
7. *Multi-user support*. The OLAP system must be able to support a multi-user environment;
8. *Flexible reporting*. The ability to arrange rows, columns, and cells in a way that facilitates visual analysis.

Decision makers should prioritize the previous list elements to reflect their business needs.

Several researchers have stated that OLAP is an independent technique and is as powerful as the data mining process and techniques [2] [10] [13]. [19] stated that in every data mining application the analyst should expect to find some relationships between the variables that describe the data set. These expected relationships need confirmation and any OLAP tool can work well in either confirming or denying these relationships. Because of this, OLAP is one of the data mining techniques applied in the early stages of the data mining process. However, unlike other data mining techniques, OLAP does not learn and hence can not search for new solutions [17] [2].

OLAP involves several basic analytical operations including consolidation, drill-down and statistical techniques [17]:

1. *Consolidation*. Consolidation involves the aggregation of data, e.g. the total number of students at the university, total courses, and average GPA;
2. *Drill-down*. This is the opposite of consolidation and involves more detailed inspection of the underlying data, e.g. the break down of the total number of students into different nationalities that belong to the different majors with different GPA. Drill-down is like adding another attribute to the original report/query [15];
3. *Slicing and dicing*. Slicing and dicing refers to the ability to look at the database from different viewpoints.

## 6. Query optimization techniques in OLAP applications

QO for OLAP applications differ from optimizing queries for OLTP applications in the following areas:

1. OLAP applications are based on data warehouse which is used for READ type transactions;
2. OLAP applications are characterized by complex queries;
3. In OLTP voluminous data are processed as soon as entered;
4. OLAP users are managers and analysts whereas OLTP users are clerks, professionals (non-managers);
5. OLAP activities are generating queries, ad hoc reports, and statistical reports;
6. OLTP are always equipped with SQL, whilst OLAP front-ends include: DSS, visualization techniques, and/or data mining techniques [22]. Data mining

refers to the process of nontrivial extraction of knowledge and discovery of previously unknown information patterns.

Because of the pre-stated reasons this paper is focused on designing strategy for optimizing queries running in OLAP environments. Oracle approach is introduced followed by MS SQL Server approach, and then the details of our suggested approach.

### 6.1 ORACLE approach

Oracle DBMS make use of MPP. Assume that a SALES relation has many records; therefore query processing on that relation will be so slow. To make sure that table scans are executed in parallel using 5 processors:

```
ALTER TABLE SALES PARALLEL 5;
```

Another parallel scanning option happens during query definition.

```
SELECT /*+ FULL (SALES) PARALLEL (SALES, 5)
*/ COUNT (*)
FROM SALES
WHERE SALESPERSON = 'ALY';
```

The /\* \*/ indicate hint to Oracle which overrides any query plan suggested by the optimizer.

In Oracle adjacent secondary memory space may contain records from various tables with different record structures [15]. Records from two or more joined relations may be stored on the same area on disk by declaring a cluster which is identified by the attribute by which the relations are already joined. Clustering reduces the time required to access related records compared to the normal allocation on various scattered areas on disk. Example is the following:

```
CREATE CLUSTER SALE (CLUSTERKEY
(CHAR(10)));
```

```
CREATE TABLE PRODUCT_TYPE (ID NUMBER
UNIQUE NOT NULL, DESC CHAR(20), NAME
VARCHAR(25), CONSTRAINT PK_PROD
PRIMARY KEY(ID)) CLUSTER SALE (ID);
```

```
CREATE TABLE PRODUCT (CODE NUMBER
UNIQUE NOT NULL, LOCATION CHAR(20), ID
NUMBER, CONSTRAINT PK_PROD PRIMARY
KEY(ID), CONSTRAINT FK_PROD_T FOREIGN
KEY (ID) REFERENCES PRODUCT_TYPE (ID))
CLUSTER SALE (ID);
```

Accessing records from the cluster is done via an index on the cluster key. Clustering records is utilized if records are static; if frequent data maintenance occurs clusters create waste space.

An index is a like the structure of a tree that permits direct access to data records in tables [18]. In Oracle indexes are classified by their logical and physical

implementation. From the logical implementation point of view there are:

1. *Single column index* that has only one attribute in the index;
2. *Concatenated columns index* that has composite columns in the index up to 32 or combined size does not exceed 1/3 of Oracle data block size;
3. *Unique index* that guarantees no two rows will have duplicate values;
4. *Nonunique index* on which multiple rows exist for the same value.

From the physical implementation point of view there are:

1. *Partitioned index* is utilized with large table to keep the index entries in several segments which improves scalability and manageability. Partitioned index is used with partitioned tables one for each partition [18];
2. *Nonpartitioned index*;
3. *B-Tree* or balanced tree, on top of which there is the root of the index that has entries which point to the next level of an index. Next level is a branch blocks which also point to the blocks at the next level. Finally, leaf level includes index entries that refer to rows in tables. Oracle also allows the use of reverse key index with B-Tree index structure [18]. A reverse index reverses the bytes of each indexed column whilst retaining the column order. Reverse index is useful for queries which have equality predicates but they never work with range queries.
4. *Bitmap index* is a table of bits such that a row represents the distinct values of a key and each column is a bit which if on implies that the record for that bit column has the associated value [15]. The bitmap index is also organized as a tree but the leaf node stores bitmaps for each value instead of a list of ROWID's in B-Tree. Oracle recommends the utilization of a bitmap index over B-tree in the following cases:
  - a. For attributes with low cardinality;
  - b. The WHERE clause include OR operators;
  - c. Read-Only of low activity attributes.

**Table (1): Bitmap index**

Row ID	Value	B <sub>7</sub>	B <sub>6</sub>	B <sub>5</sub>	B <sub>4</sub>	B <sub>3</sub>	B <sub>2</sub>
1	3	0	0	0	0	1	0
2	4	0	0	0	1	0	0
3	5	0	0	1	0	0	0
4	4	0	0	0	1	0	0
5	6	0	1	0	0	0	0
6	7	1	0	0	0	0	0
7	3	0	0	0	0	1	0
8	2	0	0	0	0	0	1
9	6	0	1	0	0	0	0
10	5	0	0	1	0	0	0

In a very simple form, bitmap index of an attribute is one vector of bits per attribute value, where the size of each bitmap is equal to the cardinality of the indexed

relation. Bitmaps are encoded such that the  $i^{th}$  record of  $v$  value in an indexed attribute iff the  $i^{th}$  bit in the bitmap associated with the attribute value  $v$  is set to 1 and the  $i^{th}$  bit for the other bitmaps are set to 0 [4]. Table 1 provides an example.

Bitmap indexes have been implemented in many DBMS including Oracle, Sybase, and Informix. A major advantage of bitmap index is that bitmap manipulations uses bit-wise operators (AND, OR, XOR, NOT) are efficiently supported by hardware.

Oracle depends on two QO approaches: *rule-based*, and *cost-based* [12]. The rule-based optimizer ranks the qeps by ranking their possible different paths according to the speed of executing each path. It ignores the table size and the distribution of data. This means that the rule based optimizer will always choose to use an index on a small table even though table scan could be more efficient.

The cost-based optimizer depends on the available access paths and statistics stored in the data dictionary e.g. number of rows and cardinality of a table to decide which access path is of least cost. The following statement analyzes the relation student, views could also be analyzed.

```
ANALYZE TABLE STUDENT COMPUTE STATISTICS;
```

Use of the analyze command is done whenever changes made to the DB to ensure that the DB optimizer depends on the most updated contents. Oracle recommends running the ANALYZE command after each data load, and before creating summary table in data warehouses [12].

Join is also optimized in Oracle by choosing the best method for doing the join. A join operation combines tuples from two or more relations based on common attributes (i.e. join condition). The Oracle QO chooses the best join method of the following (sort-merge join, nested loop join, hash join, partition wise join) for more details on join methods refer to [9] [12]. For star queries, each dimension is joined to the fact using the primary key-foreign key relationships. Oracle QO uses bitmap index to retrieve rows from the fact then the result is then join to the dimension tables, instead of computing the Cartesian product of the dimensions. Oracle recommends creating a bitmap index on every attribute on the fact table [12].

## 6.2 MS-SQL Server approach

SQL server 2000 uses memory for its stored procedures, ad hoc and prepared Transact-SQL statements, and triggers. The most significant limitation to SQL server is disk I/O; however, utilizing memory will maximize the advantages of caching and minimize memory swapping.

Memory and lock management are both managed by SQL server not the DB administrator (DBA), the server allocates buffers from the available system memory and releases them when not required [7]. This is also true for the locks, SQL server allocates and releases locks based on the activity level and the expected usage queries will make of the data.

MS SQL supports two index types; clustered and nonclustered to enhance the fast return of result sets [16]. Without indexes a query forces SQL Server to scan the entire table to find matches. A DB index contains one or more column values from tables and pointers to the corresponding record. When performing a query QO uses an index to locate matching records. MS SQL server uses B-Tree structures to store both index types. Microsoft recommends creating index on columns that are frequently used in queries. For instance, query optimizer will use reg\_no index to process the following query:  
 SELECT \* FROM STUDENT WHERE REG\_NO = 1000;

Creating index on every column in the DB tables will negatively affect performance [16]. Insert, Update, or Delete transactions will trigger the index manager to update the table indexes.

Clustered index contains table records in the leaf node of the B-Tree structure. There is only one clustered index per table. When creating PK constraint in a table without clustered index, SQL Server creates clustered index on the PK column, if a clustered index already exist a nonclustered index is created. An attribute defined as unique automatically creates nonclustered index. On most situations, clustered indexes are created before nonclustered. Index information is obtained by the following statement:

```
SP_HELPINDEX STUDENT
```

Following is a create index example in MS SQL Server:

```
CREATE UNIQUE CLUSTERED INDEX INDEX_1
ON STUDENT(NAME, GPA DESC)
WITH FILLFACTOR = 60
```

The fill factor sets up the index so that the leaf node index pages are 40% full, leaving 60% space to include additional key entries.

If a clustered index exists (on table or view) any nonclustered index on the same object uses it as their index key [16]. Dropping a clustered index by the DROP INDEX causes all nonclustered to be rebuilt so they use RID as a bookmark. In case the clustered index is re-created using CREATE INDEX all nonclustered indexes are rebuilt to refer to the clustered index rather than RID.

```
DBCC DBREINDEX (STUDENT, REG_NO, 60)
```

### 6.3 MS® SQL Server™ data retrieval policy

SQL Server language is able to filter data at the server so that only the minimum data required is returned to clients which will minimize expensive Client/Server network traffic.

This means that WHERE clauses must be restrictive enough to retrieve only the data that is required by the application. It is always more efficient to filter data at the server than to send it to the client and filter it in the application (this applies to columns). An application issues SELECT \* FROM... statement which requires the server to return all column data to the client, whether or not the client application has bound these columns for use in program variables. Selecting only the necessary columns by name avoids high network traffic.

This also makes your application more robust in the event of table definition changes, because newly added columns are not returned to the client application. Moreover, performance depends on how the application requests a result set from the server. An application based on Open Database Connectivity (ODBC), statement options set prior to executing a query to determine how the application requests a data set from the server. By default, MS® SQL Server™ 2000 sends the data set the most efficient way.

MS SQL Server assumes that an application will fetch all rows from a default result set immediately. Therefore, an application must buffer any rows that are not used immediately but could be needed later. This buffering requirement makes it necessary for you to specify (using Transact-SQL) only the data needed.

Query analyzer is a graphical tool in SQL Server that provides information about queries in nodes; each node represents a step in the query to execute [8]. For instance, a SELECT statement shows the following information:

- a. Estimated number of rows returned by the statement;
- b. Estimated size of rows;
- c. Estimated I/O cost;
- d. Estimated CPU cost;
- e. The number of times the statement was executed during running the query.

### 6.4 Comparative techniques: ORACLE versus MS-SQL

The following table (20) <sup>1</sup> summarizes the differences between Oracle and MS SQL with regard to QO.

---

<sup>1</sup> Adapted from [21].

**Table (2): Oracle vs. MS SQL Server**

Feature	Oracle	MS SQL
Indexing options	B-Tree and Bitmap index structures Reverse key index	B-Tree only
Partitioning	Range, Hash, List and composite partitioning	Cube partitioning DB partitioning and file groups
Self-tuning	Self-tuning memory, free space, I/O management	Memory management, lock management
Smart advisors	Memory wizard MTTR advisor Summary advisor Virtual index advisor	Cube wizard Query analyzer
Others	Star Schema	Star Schema and Snowflake designs

It is not the intension of this paper to say which of the Servers (i.e. Oracle and MS SQL) outperforms the other, instead to review the QO approaches in both Servers and introduce an integrated suggested approach QO approach for OLAP applications. However, reviewing both servers' mechanisms is useful for people who intent to develop OLAP applications and are not aware of the details of QO supported by each server.

## 7. Suggested QO approach for OLAP applications

Our QO suggested approach for OLAP applications includes:

- The use of intermediate queries. The following procedure is proposed:
  - As a new query ( $q_n$ ) is processed, it is compared to the previous queries in cache;
  - If there is no attribute intersection between  $q_n$  and the previous queries then  $q_n$  is processed from scratch;
  - If there is intersection between  $q_n$  and a previous query  $q_m$  then:
    - If same operator exist:
      - § E.g.  $q_n : AGE > 10, q_m : AGE > 20$ . Then finding tuples that satisfy AGE between 11 and 20 then the result Union  $AGE > 20$  from cache.
      - § E.g.  $q_n : AGE > 20, q_m : AGE > 10$ . Then finding tuples that satisfy AGE greater than 20 as a subset of cache.
    - If different operators:
      - § E.g.  $q_n : AGE > 10, q_m : AGE < 15$ . Then find the intersection between the two queries (i.e. 11, 12, 13, 14) from cache, then find tuples that satisfy  $AGE \geq 15$  and Union them.

- The use of indexes both B-Trees and Bitmap where relevant. Following is a B tree versus Bitmap comparison which helps determines when to use each of which:

**Table (3): B -tree vs Bitmap [Adapted from [18]]**

B-tree	Bitmap
High cardinality attributes	Low cardinality attributes
Inexpensive updates	Expensive
Inefficient for OR queries	Efficient for OR queries
OLTP	OLAP

- The use of memory cache (for the syntax of the query), and secondary storage cache (for the result data set).
  - Physical DB storage and its hardware solution.
- Points 3, and 4 of the suggested QO approach are explained in the following sections.

### 7.1 Pointer-based Binary Storage Model “BSM”

The idea of the binary storage model is to store each attribute with a unique location identifier in a separate table. In [5] if a non-elementary expression is processed each attribute is accessed with its physical address. We propose a modified Binary storage model called Pointer-Based binary storage model. In this model we have to specify the origin table “Table that contains the primary key” This table contains the primary key and a number of pointers equal to  $n-1$  where  $n$  is the number of columns in the virtual table including the primary key. The following example shows the proposed modeling technique.

*Example.* Consider the following student relation (i.e. table):

**Table (4): Student table**

Student ID	Student Name	Student GPA	Student AGE
91131911	Ahmed	2.5	25
95176112	Yehia	2.97	24
98117611	Mohamed	3.68	26
99876511	Ali	3.92	21

We name the last shown table structure ‘*virtual table structure*’ as it is stored in a different way than it appears to the user.

### 7.2 Physical Structure :

Each column will be stored in a table with a pointer that points to the original location.

Student Column

**Table (5): Physical structure**

Physical Location	Student ID Physical Location	Student Name
3000	1101	Ahmed
3001	1305	Ali
3002	2107	Mohamed
3003	908	Yehia

GPA column

**Table (6): Physical structure-1**

Physical Location	Student ID Physical Location	GPA
4000	1305	2.5
4001	2107	2.97
4002	1101	3.68
4003	908	3.92

AGE column

**Table (7): Physical structure-2**

Physical Location	Student ID Physical Location	AGE
5000	1305	21
5001	2107	26
5002	1101	25
5003	908	24

Student Original Table

**Table (8): Student Original table**

Physical Location	Student ID	Name Physical Location	Age Physical Location	GPA Physical Location
908	91131911	3003	5003	4003
1101	99876511	3000	5002	4002
1305	98117611	3001	5000	4000
2107	95176112	3002	5001	4001

Suppose that we want to execute the following query:  
SELECT \* FROM STUDENT WHERE GPA > 2.5

In this case we will search in the GPA table which is sorted, so binary search will be suitable to be applied. After determining the set of tuples that match the selection criterion data tuples are retrieved from the origin table that are stored in physical locations similar to those stored in the pointer attribute.

After determining those tuples data is retrieved from the rest of tables as shown:

**Table (9): Results**

Student ID	Physical Location	GPA
2107		2.97
1101		3.68
908		3.92

Then data exist in physical locations are retrieved from Original table.

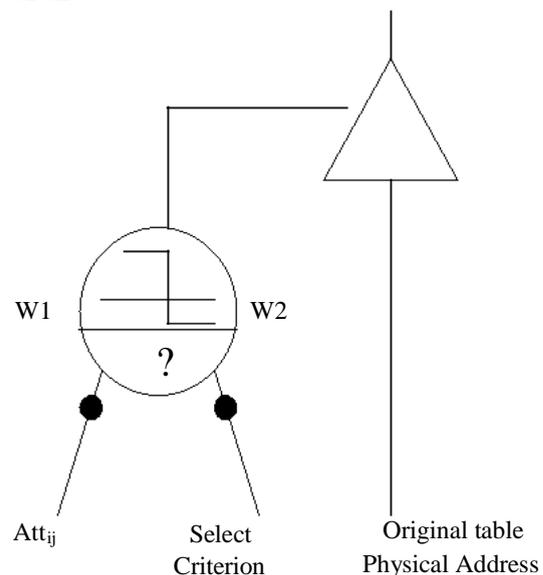
**Table (10): Source table**

Physical Location	Student ID	Name Physical Location	Age Physical Location	GPA Physical Location
908	91131911	3003	5003	4003
1101	99876511	3000	5002	4002
2107	95176112	3002	5001	4001

And then data is retrieved from the locations appear in table.

The above algorithm seems to have considerable cost. In fact this is not true because this pointer point to the physical location so there is no search after retrieving the original table selected rows.

### 7.3 Proposed H/W architecture to speed up search



**Figure (1): Suggested H/W architecture**

The previous Architecture works as follows:

The Att<sub>ij</sub> is feed to the network with the selected criteria, if the where operator is > then W1,W2 equal -1,1 respectively. if the where operator is < then W1,W2 equal 1,-1 respectively. If it is equal then both assumptions are valid.

The activation function is the inverse of the bipolar function. It is defined by:

$$f(x) = \begin{cases} 1 & \text{if } x > 0 \\ 0 & \text{if } x \leq 0 \end{cases} \quad (1)$$

The output of the neuron is feed to a tri-State device in order to either output zero and that means there is no match or outputs the physical address in case of match.

Note that VLSI (very large scale integrated circuits) technology allows the integration of huge number of replicates of this architecture in one chip. And so parallel processing for the query is achievable.

*Assumptions and constraints:*

1. For the technique to be efficient, each table has to be sorted in order to achieve efficient data retrieval “binary search”. Note that we don’t need to use B-tree algorithm as it is too costly for a sorted table.
2. Each group of tables constituting a virtual table must be stored in the same cluster in order to speed up the operation.

## 7.4 Query Result Cashing

Query caching process is divided into two sub tasks “memory cash and secondary storage cash”. We cash the query semantics and its native language transformation into memory whilst the results of the query are cashed in secondary storage i.e. hard-disk.

Since the storage media is limited in space, it is required to develop a replacement technique in order to replace existing queries by newer ones. In this paper we offer a priority-based technique that is based on the following mathematical equation:

$$Q_{IP} = B(Q_i) + H(Q_i)$$

Where  $Q_{IP}$  is the priority of the query number  $I$ . Whenever a new query is executed, it is cashed on disk and it is given a starting value  $B(Q_i)$  where  $B(Q_i)$  is a function that retrieves the base value of the priority and it is calculated as follows:

$$B(Q_i) = \frac{1}{n} \text{Avg}(Query\ Pr\ iorities)$$

and  $H(Q_i)$  is a function that represents the Query Hit Ratio which initially equals 0. Query Hit Ratio is the number of times this query has been used to answer another query.

Note that we formulated  $Q_{IP}$  to include  $B(Q_i)$  in order to give a fair chance for new queries to remain cashed. That is why we do not consider  $B(Q_i)$  a part of the Exact  $Q_{IP}$  Value so each time a new query is cashed the function  $B(Q_i)$  is decremented by 1 for all queries until it reaches 0. Note That If  $Q_2$  is a specification to  $Q_1$  and  $Q_1$  is cashed then  $Q_2$  is not cashed.

Cash Modification:

Any cashed Query that can be considered as an extension of any other cashed query must be removed.

## 8. Conclusion

- o Indexes, memory caches, portioning, clustering, hardware solutions (e.g. parallel processing) are all mechanisms to optimize query performance;
- o Query optimization for OLTP applications is different from QO for OLAP applications;

- o Bitmaps are common indexes for OLAP applications;
- o Both MS SQL and Oracle Servers support optimize queries differently;
- o A suggested QO strategy for OLAP applications should include the following components:
  - o Intermediate queries;
  - o Indexes both B-Trees and Bitmaps;
  - o Memory cache (for the syntax of the query) and secondary storage cache (for the result data set);
  - o The physical database storage (i.e. binary storage model) accompanied by its hardware solution.

## 9. Future work

- o Implementing the suggested QO approach for OLAP applications in ORACLE. *The reasons for which we did not implement our suggested approach in a case study are the following:*
  - o It is very hard to communicate with the DBMS’ query optimizers;
  - o Some DBMS (e.g. MS SQL) do not support some of the suggested techniques like bitmap indexes;
  - o It is costly to implement the suggested hardware (H/W) solution using VLSI (very large scale integrated circuits). But this does not mean that the H/W solution is infeasible, it is feasible for large organizations who store millions of records;
  - o Dumping the cached queries from memory and secondary storage requires adding new module to the existing DBMS.
- o Handling sub queries by using heuristics to determine which intermediate queries to retain.

## References

- [1] Adali, S., Candan, K., Papakonstantion, Y., and Subrahmanian, V. (1996), *Query caching and optimization in distributed mediator systems*, proceedings of SIGMOD 1996, pp.137-148.
- [2] Adriaans, P., and Zantinge, D. (1996), *Data Mining*, Addison Wesley Longman Limited, Harlow.
- [3] Berson, A. (1996), *Client/Server Architecture*, McGraw-Hill, New York.
- [4] Chan, C., and Ioannidis, Y. (1999), *Bitmap index design and evaluation*, technical report, department of Computer Science, Wisconsin-Madison University.
- [5] Choenni, S., and Siebes, A. (1996). ‘*A framework for query optimization to support data mining*’, CWI, Amsterdam.
- [6] Choenni, S., Kersten, M., Van den Akker, J., and Saad, A. (1996). ‘*On multi-query optimization*’, CWI, Amsterdam.
- [7] Craig, R. (1999). ‘*Performance Management*’, ENT, July vol. 4: 13, pp.41.

- [8] Craig, R., Vivona, J., and Bercovitch, D. (1999), ***Microsoft Data Warehousing: Building Distributed Decision Support Systems***, John Wiley & Sons Inc., New York.
- [9] Elmasri, R., and Navathe, S. B. (2000), ***Fundamentals of Database Systems***, 3<sup>rd</sup> ed., Addison Wesley, Massachusetts.
- [10] Fayyad, U., Piatetsky, G., and Smyth, P. (1996), 'From Data Mining To Knowledge Discovery: An Overview', In Fayyad, U., Piatetsky, G., and Smyth, P. (Eds), ***Advances In Knowledge Discovery And Data Mining***, AAAI Press/ The MIT Press, California, pp. 1-34.
- [11] Harinarayan, V., and Gupta, A. (1997), ***Generalized Projections: a powerful query-optimization technique***, technical report, department of Computer Science, Stanford University.
- [12] Hobbs, L., and Hillson, S., (2000), ***Oracle 8i Data Warehousing***, Digital Press, Boston.
- [13] Laudon, K., and Laudon, J., P. (2001), ***Essentials of Management Information Systems: Organization and Technology in the Networked Enterprise***, 4<sup>th</sup> ed., Prentice Hall International, Inc., New Jersey.
- [14] ***MCDBA SQL Server 7.0 Administration Study Guide***, (1999). Osborne McGraw-Hill, California.
- [15] McFadden, F., Hoffer, J., and Prescott, M. (1999). ***Modern Database Management***, 5<sup>th</sup> ed., Addison Wesley, Massachusetts.
- [16] ***Microsoft SQL Server 2000 Database Design and Implementation training kit*** (2001). Microsoft press, Washington.
- [17] O'brien, J. (1996), '***Introduction to Information Systems***', Irwin, Chicago.
- [18] ***ORACLE 8: Database Administration volume 2*** (1998). Oracle University, California.
- [19] Pyle, D. (1999), ***Data Preparation For Data Mining***, Morgan Kaufmann Publishers, Inc., California.
- [20] Schumacher, R. (1997). '***Oracle Performance Strategies***', DBMS 10, (May): pp.89-93.
- [21] ***Technical Comparison of Oracle Database vs. IBM DB2 UDB: Focus on Performance*** (2002). An Oracle white paper.
- [22] Turban, E., and Aronson, J. (1998), ***Decision Support Systems and Intelligent Systems***, 5th ed., Prentice Hall, New Jersey.
- [23] Wu, M. (1998), ***Query Optimization for Selections using Bitmaps***, Germany.

# User-Based Web Recommendation System: A Case study of the National Museum of History

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## Abstract

With the explosion and the rapidly growing market of the Internet, it is imperative that managers re-think to using technology, especially internet, to deliver services faster, cheaper, and with better quality than their competitors do. The web site provides a communication way that reveals real-time assess data and fruitful information of customers. Therefore, the call for customer with personalized web pages has become loud. To achieve personalized web pages, this study proposes recommendation algorithm of user behavior oriented by using the web log files from National Museum of History. Keywords: Web usage mining, recommendation system, Fuzzy C-means.

## 1. Introduction

The largest web sites are offering an increasing amount of information. However, the World Wide Web is a Computer-Mediated Environment [9] in which uses the hyperlinks to connect related content. Since the hyperlink is a non-linear structure [5][16], most of users waste much time in retrieving information that they do not want and thus result in reducing the number of times web sites are revisited.

Therefore, a web site manager not only need to offer complete information for visitors, users' access behavior also need to be analyzed for increasing competitive advantages. Accordingly, personalized recommendation system is an important issue to provide one-to-one guidance to the users [17] and it's become more and more important for information provider or electronic commerce.

There are two major approaches to provide personalized recommendation: content based approach and collaborative technique approach. In former, it recommends items that are similar to what the user has liked in the past [11]; in collaborative technique approach, it defines other users that have showed similar preference to the given users and recommends what they have liked [19]. [6][15][19] have proposed the earliest and the most successful collaborative recommendation technologies.

Although most of researchers have addressed the development of recommendation systems to share information among interested parties[3][4][11][21][22], there are few researches for applying on actual web page and product recommendations. Accordingly, this study proposed a user-based recommendation system.

## 2. Related Work

Data mining is the process of extracting unknown but useful information from a very large database in order to enable a manager to make a decision [2]. An increasing number of enterprises are trying to understand customer behavior and provide a quality service to increase their competitive advantages using data mining technology. Accompany with the growth of the Internet has resulted in the development of web mining. Web mining extracts the information from an unlabeled and semi-structured dataset. A web site manger can use mining to elucidate and analyze user behavior to set a marketing strategy.

Until now, [4] addresses separated web mining applications into web content mining and web usage mining. In former is based on content, hyperlinks, structure, keywords, and so on, a search engine is an example; the other is based on a web log, user preference, register, clickstream, and so on, in which users access pattern are recorded.

Data that support to web mining are usually stored in a web log which file exists on web server that interacts with the user and the web server [18][15][4]. However, when they were be used, preprocessed at first is necessary. [14] divided the preprocessed procedure into five steps: fire step is data cleaning, followed by how to define user session, web page, completely access pattern and storing.

There are two major approaches to provide personalized recommendation: content based approach and collaborative technique approach. In former, it recommends items that are similar to what the user has liked in the past [11].

Content-based method using the user access pattern or previously purchased products to compute the relevance of other page items or products. Most researchers in this area were use distance to represent the relevance of similarity among page items. The NewsWeeder system is an example [11]; Collaborative technique approach is that products or page items are ranked according to a user's preference then similarities among users are determined. When a customer enters a store, the system refers to the user's preference to find similar users and recommends products or page items in which the new user may have an interest, but which he or she has never bought, GroupLens is an example [8]. These methods depend on users' purchase experience, a user must input preferences among items and specify related items.

Furthermore, [15][18][21] also considered the clustering of users with similar access patterns, using clustering to predict another user's behavior. [15] developed robust fuzzy clustering, applied it to web mining, who used the leader algorithm proposed by [7] to cluster the similar user sessions and thus identify users with similar interests or browsing paths. [21] applied clustering approach to user access patterns, and used a method of web page recommendation developed by WebWatcher [1] and Litzia [12].

### 3. Research Method and Architecture

The study proposes a web page recommendation system. This system with two phases -- offline module and online module. The offline module prepares and preprocesses data and mines usage; the online module is involved with online recommendation and evaluates the accuracy of recommendation.

#### 3.1 Preparing and Preprocessing Data

The original web log used in the experimented was generated from httpd server. The preprocessing includes three parts – cleaning data, identifying user sessions and determining usage behavior. In order to clear the web log, .gif, .jpeg and .cgi et al., but not .html are removed.

#### 3.2 Identifying a user

Identifying a user directly from a web log is difficult. The method of identification used in this paper is to set the 30 min timeout and suppose that an IP represents a single user, to determine the order in which page are browsed.

#### 3.3 User Usage Mining

This paper considers web usage information obtained using the tool WebTrend, developed by Software Inc. Then, Fuzzy C-means clustering is to group users with similar access patterns. Accordingly similarities among users can be computed and related page items recommended to another user. The method of user-based recommendation is collaborative clustering users with similar access behavior. Common characteristics are extracted for sharing. The key steps are as follows:

First, a set of n unique URL is assumed as a vector:

$$\vec{D} = \{url_1, url_2, \dots, url_n\} \quad (1)$$

Next, a user session S is expressed as a bit vector.

$$\vec{s} = \{url_1^s, url_2^s, \dots, url_n^s\}, url_i^s = \begin{cases} 1, & \text{if } url_i \in s \\ 0, & \text{otherwise} \end{cases} \quad (2)$$

Only the click numbers are considered, so the importance of the page cannot be determined. The method is refined using the view number.

$$url_i^s = \begin{cases} \text{count}, & \text{if } url_i \in s, \text{count} ++, \text{initial count} = 0 \\ 0, & \text{otherwise} \end{cases} \quad (3)$$

Then, Fuzzy C-means clustering is used to determine the common characteristics of user behavior on which to base a recommendation. Before the fuzzy clustering is applied, the cosine of the angle between the two users is used to measure the similarity matrix. The element represents the similarity between users. A larger value implies greater similarity.

$$S_{xy} = \frac{\sum_{i=1}^{Nu} S_i^{(x)} S_i^{(y)}}{\sqrt{\sum_{i=1}^{Nu} (S_i^{(x)})^2} \sqrt{\sum_{i=1}^{Nu} (S_i^{(y)})^2}} \quad (4)$$

$N_u$ , the number of unique URL;  $S_i^{(x)}$ , the frequency that user x access;  $S_i^{(y)}$ , the frequency that user y access.

The number of clicks is used to evaluate the relative weighting of the pages,

$$\text{Weight}(url_i, c) = \sum_{s \in c} url_i^s \quad (5)$$

This result directly relates user behavior. The cluster to which each user belongs must be clearly determined. In this paper, the membership degrees of all clusters are compared and each user assigned to the highest.

Not all the work is included in a single phase, to ensure that the online recommendation is efficient. The work is separated into two phases – online and offline. The offline work is processed once a week. When the active user proposes a request, the online work is to trace who was browsed and give the user some feedback in which he may be interested.

#### 3.4 Recommendation Phase

Sliding windows [14] are used to display the most recent web page items in which the active user is very interested. For example, when the number of sliding windows equals 3, the active session is <A, B, C>, and once the user requests page D, the active session becomes <B, C, D>.

No absolute method governs the decision of the appropriate number of page items. In this study, the default value is set to ten. Recommending the related page items for different users. There are three key steps: First, the bit vector is  $S_A$  used to represent the active user's trace.

Next, the similarity between the active user and a group of users is computed.

$$SC_j^s = \sum_{i=1}^n (URL_i^s \times URL_i^A) \quad (6)$$

$SC_j^s$  is the score for each session that are compared with active session  $S_A$ ;

$SC_j^s$  is multiplied by the membership degree in each jth cluster. The formula is following:

$$\text{match}(C_i) = \prod_{j=1}^n (S_j^{\text{deg rec}} \times SC_j^s) \quad (7)$$

Finally,  $\max\{\text{match}(C_1), \text{match}(C_2), \dots, \text{match}(C_i)\}$ , for all  $C_i \in C$ . The result is the cluster has the highest similarity to the active user. From the  $C_i$ , the top ten web page items are recommended according to the relative weights.

### 3.5 Evaluating the Result

Recall and precision [10] are used to evaluate the accuracy of the recommendation system. These indices are generally used in information retrieval. Recording the top ten recommended pages links for each page is difficult. Therefore, only the recall value is considered in the evaluation according to the following formula.

$$\text{Recall} = \frac{\|\text{actually browse recommended page items}\|}{\|\text{actually browse}\|} \quad (8)$$

$\|\text{Knumber of web pages items}\|$

## 4. An experiment and Result

One million web log records were collected from the National Museum History from 1999/7 to 2001/11. A mirror based on the FreeBSD 4.5 platform was used to avoid influencing the original web site. Graphical records and those of clicks of about ten web page in 30 seconds were removed.

Identifying a user is difficult. The timeout was set to 30 minutes. The percentage of users who clicked less than ten pages was nearly 96%. Only the 143 user sessions of browsing of over 20 web pages were extracted.

The web site has a total of 46 web pages, six pages were clicked more than remnant (1327).

Before similar user characteristics can be clustered, the similarity between users must be computed. First, a bit vector is used to identify a user who clicks the page. Secondly, the cosine angle is used to compute the similarity to construct a 143\*143 matrix, which is clustering base. In this matrix, all the elements on the diagonal are 1.

We use Fuzzy C-means is used to cluster similar users and Compactness and Separation Validity Functional [20] are used to measure the clusters' validity.

Figure 1 presents an example of the recommendation result. Frame is used to show the recommended pages dynamically.

52 users were invited to click the web pages and 929 records were recorded. Eight users' clickstreams were under three and 12 web logs may have been created by reloading events, and were removed. Finally, 44 users will with a clickstream of 917, in which 865 were the recommendation page items, the recall value was 865/917=94.32%.

## 5. Conclusion and recommendation

To achieve personalized web pages, this study proposed recommendation algorithm of user behavior oriented by using the web log files from National Museum of History and to evaluate the algorithm according to the recall value.

Some issue and questions remain outstanding: first, obtaining web log information is difficult. Therefore, the suitability of the recommendation system for other web sites cannot be evaluated. Next, the recommendation system involves mining user behavior. In the future, content mining will be included to improve the accuracy of recommendation and fit the users' interests. Then, Scanning the databases many times increases the time taken, extends the computation period, and increases the number of users. Finally, making the algorithms efficient and determining the optimal number of clusters remains important outstanding issues.



Figure 1: The recommendation result

## Reference

- [1] Armstrong R., Freitag T., Joachims and Michell, T. (1995), WebWatcher: A Learning Appretice for The World Wie Web, AAAI Spring Symposium on Information Gathering from Heterogeneous, Distributed Environments, March 1995.
- [2] Cabena Peter, Hadjinian, Pablo, Stadler, Rolf, Verhees, Jaap and Zanasi, Alessandro, Discovering Data Mining from Concept to Implementation, New Jersey, Prentice Hall PTR, 1998.
- [3] Chen M.S., Park J.S. and Yu P.S., Data mining for path traversal patterns in a Web environment, In Proceedings of the 16<sup>th</sup> International Conference on Distributed Computing Systems, pp. 385-392, 1996b.
- [4] Cooley R., Mobasher B. and Srivastava J., Web mining: Information and Pattern Discovery on the World Wide Web, Proceedings of the 9<sup>th</sup> International Conference on Tools with Artificial Intelligence (ICTAI'97), pp. 558-567, 1997.
- [5] Delisle, N. and Schwartz, M., Contexts: A Partitioning Concept for Hypertext, ACM Transactions on Office Information Systems, pp. 168--186, April 1987.
- [6] Fu X., Budzik J., Kristian J.H., Mining Navigation History for Recommendation, ACM, pp. 106-112, 2000.
- [7] Hartigan J., Clustering Algorithms, John Wiley., 1975.

- [8] Herlocker J., Konstan J., Borchers A. and Riedl J., An Algorithmic Framework for Performing Collaborative filtering, To appear in Proceedings of the 1999 Conference on Research and Development in Information Retrieval, August, 1999.
- [9] Hoffman D.L. and Novak T.P., Marketing in Hypermedia Computer-Mediated Environment: Conceptual Foundations, *Journal of Marketing*, pp. 50-68, July 1996.
- [10] Kowalski, G., *Information Retrieval Systems -- Theory and Implementation*, Kluwer Academic Publishers, 1997.
- [11] Lang K. Newsweeder: Learning to Filter Netnews, In Proceedings of the 12<sup>th</sup> International Conference on Machine Learning, Tahoe City, Calif, 1995.
- [12] Lieberman H.L. (1995), An Agent that Assists Web Browsing, In International Joint Conference on Artificial Intelligence, Montreal, August.
- [13] Mannila H. and Toivonen H., Discovering generalized episodes using minimal occurrences, In Proc. Of the Second Int'l Conference on Knowledge Discovery and Data Mining, pp. 146-151, Portland, Oregon, 1996.
- [14] Mobasher B., Cooley R. and Srivastava J., Automatic Personalization Based on Web Usage Mining, *Communications of the ACM*, Vol. 43, No. 8, August 2000, pp. 142-151.
- [15] Nasraoui O., Krishnapuram R. and Joshi A., Mining Web Access Logs Using a Fuzzy Relational Clustering Algorithm based on a Robust Estimator, Proceedings of WWW8, August, 1999.
- [16] Nielsen J., *Hypertext and Hypermedia*, USA Academia Press, Inc, 1990.
- [17] Resnick, P., Neophytos, I., Miteth, S., Bergstrom, P. and Riedl, J., GroupLens: An Open Architecture for Collaborative Filtering of Netnews. In Proceedings of CSCW94, Conference on Computer Supported Cooperative Work (Chapel Hill NC). Addison-Wesley, pp. 175-186, 1994.
- [18] Shahabi C., Zarkesh A.M., Abidi J. and Shah V., Knowledge Discovery from User's Web-page Navigation, Proc. Seventh IEEE Intl. Workshop on Research Issues in Data Engineering (RIDE), pp. 20-29, 1997.
- [19] Shardanand, U. and Maes, P., Social Information Filtering: Algorithms for Automating 'Word of Mouth', In Processings of CHI95 (Denver CO), ACM Press, pp. 210-217, 1994.
- [20] Xie X.L. and Beni G., A Validity Measure for Fuzzy clustering, *IEEE Transactions on Pattern Analysis and Machine Intelligence*, Vol. 13, No. 8, pp. 841-847, August 1991.
- [21] Yan T., Jacobsen M., Garcia-Molina H. and Dayal U., From user access patterns to dynamic hypertext linking, In Fifth International World Wide Web Conference, Paris, France, 1996.
- [22] Zaiane O.R., Xin M. and Han J., Discovering Web access patterns and trends by applying OLAP and data mining technology on Web logs, in Proc. Advances in Digital Libraries ADL98, pp. 19-29. 1998.
- [23] Software Inc. Webtrends. <http://www.webtrend.com>, 1995.

# Clustering Graduate Theses Based on Key Phrases Using Agglomerative Hierarchical Methods: An Experiment

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## An Experiment

### Abstract

Document clustering is an important tool for applications such as Web search engines. Document clustering can be defined as the process of organizing documents into groups. The groups thus formed have a high degree of association between members within the same group and a low degree of association between members of different groups. The goal of this paper is to present an experiment on one of the most widely used document clustering algorithms, namely, the agglomerative hierarchical algorithm. In our experiment, two set of graduate theses are clustered based on the key phrases assigned to each document by the author(s). Overall, the clustering results of our clustering scheme are considered to be very good.

Keywords: Document Clustering, Agglomerative Hierarchical Clustering, Complete Link, Data Mining.

### 1. Introduction

Document clustering is an important tool for applications such as Web search engines. The widely application of WEB technology has created a huge amount of web pages and the number of web pages is still increasing. According to an International Data Corporation report, the annual growth rate of storage media is more than 130%. Due to the huge amount of web pages, search engines have to be developed to help web users to search and retrieve information from the web in a timely fashion. As the number of web pages increases, the efficiency of web storage and retrieval becomes an important issue. Since the classification of web contents and the organization of web storage can have critical impacts on the retrieval performance of a search engine, some search engines, such as YAHOO, organize the web storage by means of laborious, time-consuming classification procedures. However, the accelerating influx of new web pages threatens to outpace the ability of human experts to classify the web contents. Therefore, automatic classification (also referred to as cluster analysis or clustering) methods must be developed to help alleviate this burden. Furthermore, search engines may return too many web pages for a particular key word search. Again clustering can be used to generate a category structure and enable users to have a better overview of the information contents [1].

Document clustering can be defined as the

process of organizing documents into groups. The groups thus formed have a high degree of association between members within the same group and a low degree of association between members of different groups. While clustering is often referred to as automatic classification, it is not accurate strictly since the clusters formed are not known prior to processing, but are defined by the items assigned to them [2]. Clustering is useful to provide structure in large data sets, because it is not necessary for the clusters (and often the number of clusters) to be identified prior processing. Thus, it has been described as tool of discovery and also has been an important research area in data mining [3]. There are two major styles of clustering: partitioning (often called k-clustering), in which every document is assigned to exactly one group, and hierarchical clustering, in which each group of size greater than one is in turn consisted of smaller groups [2]. Both had been studied extensively by the mid-1970's, and comparatively less clustering research in the 1980's. However, the widely application of Web technology and the large amount of data thus created have lead to a renewal of interest in clustering algorithms. The goal of this paper is to present an experiment on one of the most widely used document clustering algorithms, namely, the agglomerative hierarchical algorithm.

Clustering can be performed on documents in several ways, such as clustering documents based on the terms that they contain, clustering documents based on co-occurring citations, and clustering terms based on the documents in which they co-occur [2]. In this experiment, two set of graduate theses from Taiwan are clustered based on the key phrases assigned to each document by their author(s).

The rest of the paper is organized as follows: section 2 describes the general agglomerative hierarchical clustering algorithm, section 3 describes the detail of our experiment, section 4 presents some results of the experiment, and the conclusions are given in section 5.

### 2. The Agglomerative Hierarchical Clustering Algorithm

The agglomerative hierarchical document clustering process includes the following three steps:

- (1). Select the attributes for each document to be clustered. In principle, document clustering might involve a direct comparison of words or sentences

used in documents. However, the vocabularies of normal documents show substantial variety and the number of words or sentences included in many documents may be so large that a complete text comparison between different documents becomes impossible. Thus, it is advisable to characterize document by assigning special content descriptions, or profiles, which serve as document surrogates during cluster analysis [4]. The process of constructing identifiers as surrogates for documents is known as indexing. The choice of index terms should consider the degree that all aspects of the subject matter of a document are actually recognized and the index terms can somehow distinguish between different documents. Since indexing is rather a complex task, it was normally performed intellectually by subject experts, or by trained persons with experience in assigning content descriptions. It has been a routine for an author to assign key words for the document he/she has created. Thus, the key words assigned by the author(s) can be served as attributes for a document and used as the basis for cluster analysis.

- (2). Select an appropriate similarity measure from those available. There are a variety of distance and similarity measures, such as Simple Matching Coefficient, Dice Coefficient, Jaccard Coefficient, Overlap Coefficient, and Cosine Coefficient [5,6]. A list of the similarity measures appears in Table 1.

Table 1. The Similarity Measures and Definitions

Similarity Measures	Definitions, $\text{Sim}(D_i, D_j) =$
Simple matching coefficient	$\frac{ T_i \cap T_j }{ T_i \cup T_j }$
Dice coefficient	$\frac{2 T_i \cap T_j }{ T_i  +  T_j }$
Jaccard coefficient	$\frac{ T_i \cap T_j }{ T_i \cup T_j }$
Overlap coefficient	$\frac{ T_i \cap T_j }{\max( T_i ,  T_j )}$
Cosine	$\frac{ T_i \cap T_j }{\sqrt{ T_i  \times  T_j }}$

Where  $T_i$  is the set of terms assigned to document

$D_i$ ,  $T_j$  is the set of terms assigned to document

$D_j$ , and  $|T_i|$  is the number of elements of set  $T_i$ .

The Dice, Jaccard and cosine coefficients are three typical similarity measures, which have the attractions of simplicity and normalization and have often been used for document clustering [2]. The Jaccard is selected as the similarity measure for its simplicity in this experiment to calculate the similarity matrix for the initial data collection.

- (3). Create the clusters or cluster hierarchies. Based on the similarity matrix, the two closet clusters are combined to form a new cluster. Once new clusters are created, the similarity matrix between clusters needed to be recalculated. The clustering process is repeated until a single cluster is obtained or there are no pairs of clusters having a similarity value larger than a predefined threshold. To calculate the similarity between clusters which have two or more members, four commonly used methods, namely, single link, complete link, group average link, and Ward's method can be used [2,7]. The clustering structure resulting from a hierarchical agglomerative clustering is often display as dendrogram as shown in Figure 1.

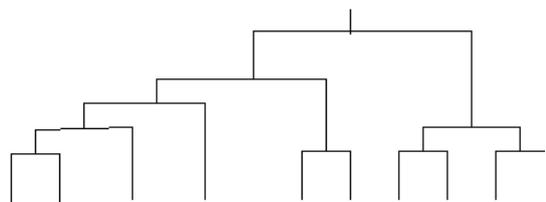


Figure 1. Dendrogram of a Hierarchical Clustering

These four methods are also called maximum distance, minimum distance, group average distance, and centroid distance respectively. Their definitions are as follows:

ò Minimum distance :

$$d_{\min}(C_i, C_j) = \min_{p \in C_i, p' \in C_j} |p - p'|$$

ò Maximum distance :

$$d_{\max}(C_i, C_j) = \max_{p \in C_i, p' \in C_j} |p - p'|$$

Mean distance :  $d_{\text{mean}}(C_i, C_j) = |m_i - m_j|$

Average distance :

$$d_{\text{avg}}(C_i, C_j) = \frac{1}{n_i n_j} \sum_{p \in C_i} \sum_{p' \in C_j} |p - p'|$$

Where  $C_i$  or  $C_j$  represents a cluster, and  $p$  and  $p'$  are points (or members) of a cluster. Among the four typical measures, the complete link method has been shown to be most effective for larger collections [8] and is used for our experiment, since the size of document collection for the experiment is fairly large.

### 3. Experimental Details

The agglomerative hierarchical clustering algorithm used in this experiment can be summarized as the following steps:

- (1). Initially assume that each document item forms a cluster.
- (2). Calculate the similarity matrix for each pair of clusters using Jaccard Coefficient.
- (3). Identify the two closest clusters and combine them in a cluster.
- (4). Recalculate the similarity matrix for the newly created clusters using complete link method.
- (5). If more than one cluster remains and there are some pairs of clusters whose similarity is greater than the threshold, which is set to 0 in our experiment, return to step (3).

The algorithm can be illustrated by example 1.

Example 1:

Step 1: Initially assume that each document item forms a cluster. Consider a document collection consists of ten documents, and the set of key phrases for the documents are  $T_1, T_2, T_3, \dots, T_{10}$  respectively.

The key phrase sets are shown in Table 2.

Table 2. The Key Phrases Assigned to Documents

Documents	Key phrases
$T_1$	K1 K2 K3 K4
$T_2$	K5 K6 K7
$T_3$	K8 K9
$T_4$	K2 K3
$T_5$	K6 K7 K10

$T_6$	K8 K11 K12
$T_7$	K9 K11
$T_8$	K3 K4 K13 K14
$T_9$	K5 K6 K15 K16
$T_{10}$	K8 K11 K17 K18 K19

Let each document forms a cluster by itself, so there are ten clusters, denoted as  $(T_1), (T_2), (T_3), \dots, (T_{10})$ .

Step 2: Calculate the similarity matrix for each pair of clusters. Using Jaccard coefficient, for example, the similarity between  $T_1$  and  $T_4$  is :

$$\text{Sim}(T_1, T_4) = \frac{|T_1 \cap T_4|}{|T_1 \cup T_4|} = \frac{| \{K2, K3\} |}{| \{K1, K2, K3, K4\} |} = \frac{2}{4} = 0.5.$$

Similarly, the similarity matrix,  $M_1$ , for the document collection can be calculated and shown in Figure 2.

$$M = \begin{matrix} & (T_1) & (T_2) & (T_3) & (T_4) & (T_5) & (T_6) & (T_7) & (T_8) & (T_9) & (T_{10}) \\ \begin{matrix} (T_1) \\ (T_2) \\ (T_3) \\ (T_4) \\ (T_5) \\ (T_6) \\ (T_7) \\ (T_8) \\ (T_9) \\ (T_{10}) \end{matrix} & \begin{bmatrix} 0 & 0 & 0.5 & 0 & 0 & 0 & 0.33 & 0 & 0 \\ 0 & - & 0 & 0 & 0.5 & 0 & 0 & 0 & 0.4 & 0 \\ 0 & 0 & - & 0 & 0 & 0.25 & 0.33 & 0 & 0 & 0.17 \\ 0.5 & 0 & 0 & - & 0 & 0 & 0 & 0.2 & 0 & 0 \\ 0 & 0.5 & 0 & 0 & - & 0 & 0 & 0 & 0.17 & 0 \\ 0 & 0 & 0.25 & 0 & 0 & - & 0.25 & 0 & 0 & 0.33 \\ 0 & 0 & 0.33 & 0 & 0 & 0.25 & - & 0 & 0 & 0.17 \\ 0.33 & 0 & 0 & 0.2 & 0 & 0 & 0 & - & 0 & 0 \\ 0 & 0.4 & 0 & 0 & 0.17 & 0 & 0 & 0 & - & 0 \\ 0 & 0 & 0.17 & 0 & 0 & 0.33 & 0.17 & 0 & 0 & - \end{bmatrix} \end{matrix}$$

Figure 2. The Similarity Matrix of  $M_1$

Step 3: Identify the two closest clusters and combine them into a cluster. In this case,  $(T_1)$  and  $(T_4)$  are combined to form a new cluster  $(T_1, T_4)$ , also  $(T_2)$  and  $(T_5)$  are combined to form another new cluster  $(T_2, T_5)$ .

Step 4: Recalculate the similarity matrix for the newly created clusters using complete link method. The similarity matrix,  $M_2$ , for newly created clusters is shown in Figure 3.

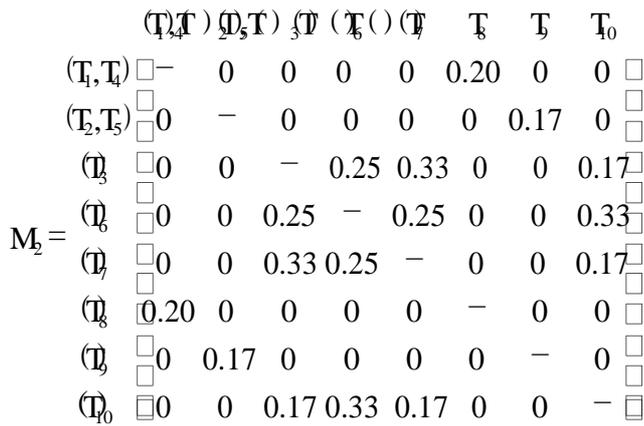


Figure 3. The Similarity Matrix of  $M_2$

Step 5: If more than one cluster remains and there are some pairs of clusters whose similarity is greater than 0, return to step 3. In this case the algorithm returns to step 3.

The process repeats until the condition stated in step 5 is not true and eventually the final similarity matrix,  $M_f$ , is created and shown in Figure 4.

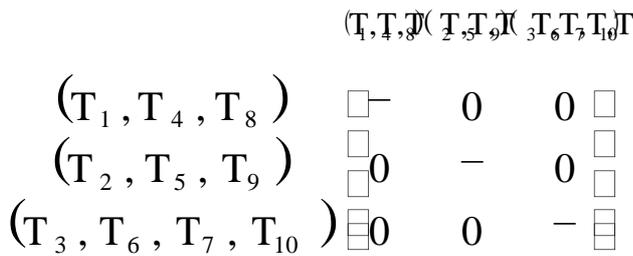
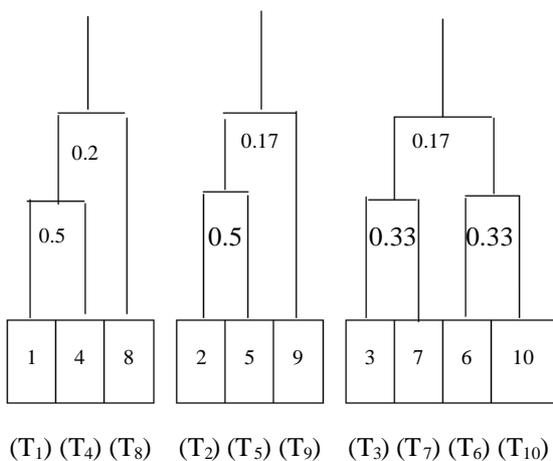


Figure 4. The Final Similarity Matrix of  $M_f$

Finally, the clusters  $(T_1, T_4, T_8)$ ,  $(T_2, T_5, T_9)$ ,  $(T_3, T_6, T_7, T_{10})$  are created and the clustering process is shown in Figure 5.



$(T_1) (T_4) (T_8)$   $(T_2) (T_5) (T_9)$   $(T_3) (T_7) (T_6) (T_{10})$

Figure 5. The Agglomerative Hierarchical Document Clustering Process

## 4. Experimental Results

Two data sets of graduate theses published by universities in Taiwan are used as clustering targets in this experiment. The first data set consists of 411 master theses published by 8 departments<sup>1</sup> from Central Police University. The second data set is the graduate theses published in Taiwan and is a much bigger collection, but due to computation time limit only 1078 master theses published by 5 different departments<sup>2</sup> in Taiwan are used for the experiment. The clustering of the first data set shows that most theses published by an academic department form one single cluster. Only the theses published by the Department of Police Administration are clustered into two different clusters. So totally, 9 clusters are created. Although, the theses published by Police Administration Department form two clusters, 98.56% of them are clustered into one cluster.

The number of clusters created from clustering the second data set is 36, which is much bigger than 5. However, 89.4% of atmospheric science theses, 90.3% of marine biology theses, 89.6% of international economics theses, 90% of plant pathology theses, and 86.7% of electro-physics theses, are clustered into five main clusters respectively. Overall, the clustering results are considered to be very good.

## 5. Conclusions

In this paper, we have described the agglomerative hierarchical clustering method in detail and the experiments to cluster two collections of graduate theses. It is shown that based on the key phrases assigned to documents by the author(s), the agglomerative hierarchical clustering method is able to cluster most (about 90%) of the theses published in one academic area to a single clusters. For theses published by Central Police University, the clustering result is much better, and this may due to that the research area of Police University is more specific and better focused.

Since the academic departments are often used as the categories for classification, we conclude that our clustering scheme is promising for automatic document classification if the clustering granularity is on the academic department basis. For clustering documents on other levels of granularity, terms or individual words besides key phrases and also associated their weights might be used as surrogates for documents. In that case the clustering scheme will be more complex to implement and thus more computation efforts is needed.

<sup>1</sup> They are police administration, fire science, criminal police, traffic administration, information management, crime prevention, forensic science, and law.

<sup>2</sup> They are atmospheric science, marine biology, international economics, plant pathology, and electro-physics.

## References

- [1] K. I. Lin, and R. Kondadadi, "A Word-Based Soft Clustering Algorithm for Documents", [www.mscl.memphis.edu/~linki/\\_mypaper/CATA01.doc](http://www.mscl.memphis.edu/~linki/_mypaper/CATA01.doc)
- [2] W. B. Frakes, and R. Baeza-Yates, Information Retrieval: Data Structure & Algorithms, Prentice Hall, 1992.
- [3] D. Fasulo, "An analysis of recent work on clustering algorithms", [http://www.cs.washington.edu/homes/dfasulo/\\_clustering.ps](http://www.cs.washington.edu/homes/dfasulo/_clustering.ps), 1999.
- [4] G. Salton, Automatic Text Processing: The Transformation, Analysis, and Retrieval of Information by Computer, pp-275, Addison Wesley, 1989.
- [5] M. R. Anderberg, Cluster Analysis for Applications, Academic, 1973.
- [6] 彭怡菁, 以統計量測為基礎之交易資料集分群, Master Thesis, National Taiwan University, 2001.
- [7] J. Han and M. Kamber, Data Mining: Concepts and Techniques, Morgan Kaufmann Publishers, August 2000.
- [8] E. M. Voorhees, "The effectiveness and Efficiency of Agglomerative Hierarchic Clustering in Document Retrieval", Ph. D. Thesis, Cornell University, 1986.
- [9] M. Berry and G. Linoff, Data Mining Techniques for Marketing, Sales, and Customer Support, John Wiley and Sons, 1997.
- [10] A.K. Jain, M.N. Murty and P.J. Flynn, "Data Clustering: A Review", ACM Computing Surveys, Vol. 31, No. 3, pp.264-323, 1999.
- [11] G. Jones, A. M. Robertson, C. Santimetvirul, and P. Willett, "Non-Hierarchic Document Clustering Using A Genetic Algorithm", <http://informationr.net/ir/1-1/paper1.html>.

# The Relationships between Individual Differences and the Quality of Learning Outcomes in Web-based Instruction

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## Abstract

The use of web-based instruction is becoming widespread in higher education, however much remains to be learned about how different learners perceived such instructional programmes. The study presented in this paper evaluates students' learning performance and their experience in a web-based instructional programme, which was applied to teach students how to use HTML in Brunel University's Department of Information Systems and Computing. Sixty-one Masters students participated in this study. A number of interesting interactions were found. Students' task achievements were affected by the levels of their previous system experience. On the other hand, the Post-Test and Gain scores were positively influenced by their perceptions and attitudes toward the web-based instructional programme. The implications of these findings are discussed.

## 1. Introduction

As one of the most recent developments in learning technology, the web stands to offer significant innovation to the improvement of delivering instructional material. The value of such innovation does not only provide a new way for teaching and learning, but also allows instructors to do traditional things in new ways [1]. This is the probable reason as to there has been an increased growth in the use of the web for teaching and learning. In particular, many institutions in higher education have used the web to support university courses. However, the drawback is that the responsibility for designing learning paths through web-based instructional programmes becomes that of the students. Some students who lack independent learning skills may find it difficult to interact with web-based instruction programmes, so their learning achievement may be disrupted, limiting the outcome of their learning and reducing its effectiveness.

In order to understand the effectiveness of web-based instruction at an individual learner level, it is necessary to see how different people perceive web-based instruction. Therefore, empirical evaluation of learners' preferences becomes paramount because such evaluation can provide prescriptions for developing student-centred learning environments that can match with learners' particular needs. The purpose of this

paper is to reflect the actual student experience of interacting with a web-based instruction programme to present prescriptions for the design of such programmes.

## 2. Web and Individual Differences

Today, many institutes in higher education apply web-based instruction to develop university courses. Web-based instruction utilises hypermedia techniques to provide students with freedom of navigation. Students can control their navigation paths that may help them to develop their own knowledge structure. The development of web-based instruction programmes provides students with many opportunities to explore, discover, and learn in theory according to their own information needs.

On the other hand, the freedom offered by web-based instruction may come with a price. Quintana (1996) states that while students gained the advantage of flexibility in time, pace, and distance with web-based instruction programmes, many students felt isolated, suffered from a lack of motivation, or lack of support, and found that the feedback provided was too limited and consequently dropped out of the course [15]. Hedberg and Corrent-Agostinho (2000) indicate that some students considered web-based instruction to be a difficult learning medium, showing their concern by asking for more incentives, more time, more structure, and more guidance [8]. These studies provide evidence that not all types of learners appreciate being given control over constructing their own knowledge structure. In particular, students who need more guidance through the learning process may meet an increased number of problems in using web-based instructional programmes. Therefore, research that examines the relationships between individual differences and web-based instruction has mushroomed in the past several years. Such differences include cognitive style [18, 4], gender differences [6, 5], system experience [16, 2], and domain knowledge [10].

However, some problems still exist in current studies. For example, most studies measure learning with either theoretical knowledge or practical tasks. Very few studies consider both theoretical knowledge and practical tasks. In addition, paucity of studies integrates the findings of learning outcome with those of perceptions and attitudes. Therefore, there is a need to provide empirical evidence to identify whether there is a close relationship between students' learning

outcome and perceptions to learning environments. The present study attempts to address these problems. The approaches to addressing these two problems in this study are: (a) students' learning outcomes are measured by both theoretical knowledge and practical tasks in a web-based instruction program; and (b) the interactions between students' learning outcomes and perceptions are explored.

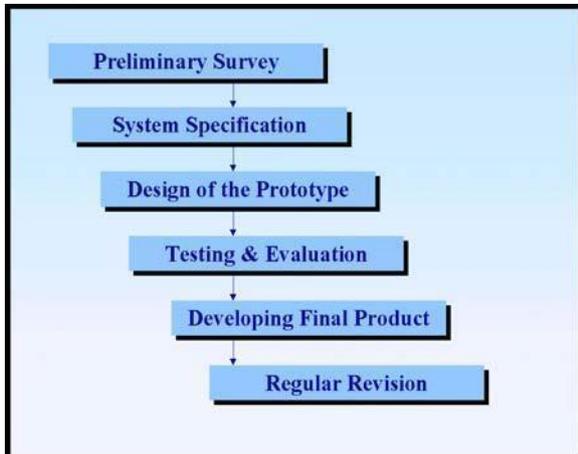


Figure 1: Development process

### 3. Curriculum Design

Curriculum design is a critical issue in the process of implementing web-based instruction. The sections below describe the approaches of the curriculum design in the development of web-based instruction, which include two important elements: creation of instructional material and assessment of learning

outcome.

### 3.1 Creation of Instructional Material

#### 3.1.1 Development Process

Instead of taking a technology-centred approach, the whole development process took a student-centred approach. In other words, the student was central to development process and continually gave input to the improvement of the web-based instructional programme. This approach was to make sure that the web-based instructional programme could meet with the students' particular needs.

As showed in Figure 1, the whole design process included six steps. The preliminary survey, which was the first and most important step, aimed to identify the students' understanding in this subject and to ensure that the level and presentation of the content were matched with their capabilities.

In order to reach this aim, a series of activities were conducted, including:

- f Observation by sitting in the lecture was used to find students' difficulties in studying this subject;
- f Informal discussion was conducted with the lecturers to ascertain their opinions of the students' capabilities;
- f Comprehensive lecture notes and learning materials were collected and analysed in details;
- f An in-depth study of other similar web-based instructional programmes in the relevant subject areas was conducted.

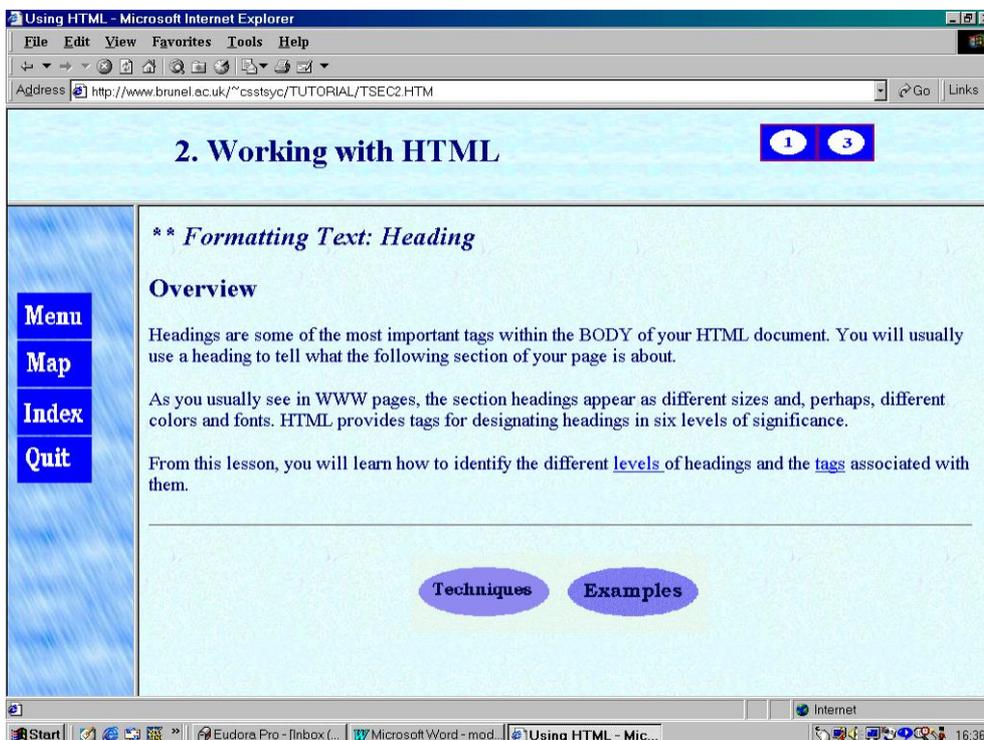


Figure 2: Screen design of the web-based instructional programme

Table 1: Three Types of Navigation Control

Control	Purposes	Tools
Sequence Control	To allow students to decide the sequence of subjects to be learned;	<ul style="list-style-type: none"> <li><i>f</i> Subject Maps: to show all topics and sub-topics in a hierarchical way;</li> <li><i>f</i> Keyword Index: to list keywords in an alphabetical way;</li> <li><i>f</i> Back/Forward: to see the page previously visited;</li> </ul>
Content Control	To allow students to control the selection of the contents they wish to learn;	<ul style="list-style-type: none"> <li><i>f</i> Section Buttons: to choose three sections of the main content;</li> <li><i>f</i> Main Menu: to present main topics;</li> <li><i>f</i> Hypertext Links: to connect relevant concepts;</li> </ul>
Display Control	To allow students to choose one of several display options that cover the same concept.	<ul style="list-style-type: none"> <li><i>f</i> Display Options: to include overview, examples, and detailed techniques, etc.</li> </ul>

According to the results of the preliminary work, a system specification was developed and was employed to define the content, functionality and usability of the web-based instructional programme. A prototype was then designed based on the system specification and the students were invited to test and evaluate its function and contents. Their opinions were summarised and were used to implement the final product. It is important to note that implementing the final product is not the end of the development process. Revising the content on a regular basis is important because it can get students to re-visit the web-based instructional programme frequently.

### 3.1.2 Content Presentation

The subject matter of the web-based instructional programme was related to an introduction to using HTML. The programme began by giving an introduction to the learning objectives and explaining the available navigation approaches provided in the instructional programme. The contents were divided into three sections: (1) What is HTML? (2) Working with HTML, and (3) Relations with SGML and WWW. Section 2, which covers twelve sub-topics of HTML authoring, is the key element of the web-based instructional programme. Each sub-topic was further split into five parts, comprising (a) overview, (b) detailed techniques, (c) examples, (d) related skills, and (e) references. Information was presented in 82 pages using texts, tables, index, and maps. The contents of the web-based instructional programme were divided into seven hierarchical levels.

As shown in Figure 2, the screen was divided using frames. In the top frame was a title bar showing the section name being viewed and the other available section buttons. In the left frame were the Main Menu, Index, Map, and Quit buttons. The right frame displayed the main content for each section, including topic buttons and text-based hypertext links.

### 3.1.3 Navigation Control

The web-based instructional programme took advantage of non-linear learning and provided students with freedom of navigation. Topics and sub-topics could be studied in any order. In other words, students were allowed to decide their own navigational routes through the subject matter. Three types of navigation control were available in this programme as shown in Table 1.

## 3.2 Assessment of Learning Outcome

The objectives of the assessment were to examine the students' learning outcomes and the factors that affect these. Students are required to demonstrate their understanding of the fundamental technologies that underpin HTML authoring and to express their learning experience in using the web-based instructional programme. To achieve these objectives effectively, three types of the assessment were developed:

- f* Pre-Test and Post-test: to reflect students' theoretical knowledge;
- f* Practical Task: to reflect students' real skills of using HTML;
- f* Exit Questionnaire: to reflect students' learning experience.

### 3.2.1 Pre-Test and Post-Test

Examining students' theoretical knowledge was conducted by developing Pre-Test and Post-Test. Students were evaluated with a Pre-Test to examine their levels of prior HTML knowledge and with Post-Test to assess learning achievement. Both these tests were presented in paper-based formats and included 20 multiple-choice questions. There was only one right answer for each question. The formats of the questions were similar, with only the specific subject of the question being modified. The questions covered all three sections of the web-based instructional program from basic concepts to advance topics.

Students were allotted 20 minutes to answer each test and were not allowed to examine the content presented in the web-based instruction at the same time. Students' learning outcomes were assessed by:

- f* Post-Test Score: the sum of each student's score on the Post-Test, ranging from 0 to 20;
- f* Gain Score: score difference between the Pre-Test and the Post-Test in order to ascertain how much knowledge had been gained.

### 3.2.2 Practical Task

Students were assigned to do a practical task, which involved constructing a web page using HTML in order to measure learning outcome on the real skills that they had learnt. The practical task entailed 10 key areas (e.g. creating hypertext links, changing background colours, formatting text, etc.). A printed task sheet that described the detailed features of the web page to be completed was given to the students, who were allowed to decide the order in which they attempted to complete the task activities on the sheet. They were also allowed to look at the content of the web-based instruction programme simultaneously.

One and a half hours were allocated for each student to complete the task. The starting time and the end time for each student were recorded. Students' task achievement was evaluated by:

- f* Task Score: a score consisting of summing items successfully completed, on a 0-10 scale;
- f* Task Time: the total time spent for completing the whole task activities.

### 3.2.3 Exit Questionnaire

The exit questionnaire was divided into two parts. The first part was the assessment of the web-based instructional programme, including (a) levels of understanding, (b) content description, (c) presentation and explanation, (d) functionality and usability, and (e) difficulties and problems. The second part contained information regarding biographical data of students and their experience with using computers, the Internet, and HTML.

The assessment contained three open-ended questions and 47 closed statements. The open-ended questions were related to students' opinions about the strengths and weaknesses of the web-based instructional programme and the barriers that they met. Students were requested to express their opinions in their own words. Enough space was provided for them to write down their opinions. Each closed statement could be classed as either in favour or not in favour of the programme. The numbers of statements in favour was almost equal to those statements not in favour (20 statements in favour and 27 statements not in favour), in an attempt to reduce bias in the questionnaire. All statements used a five-point Likert Scale consisting of: strongly agree, agree, neutral, disagree, to strongly disagree. Students' perceptions and attitudes were measured by

- f* Positive Perceptions: the sum of the scores for all favoured statements of the Exit Questionnaire;
- f* Negative Attitudes: the sum of the scores for all not-favoured statements of the Exit Questionnaire.

## 4. Student Experience

The section below presents the results of how individual differences influence student learning in the web-based instructional programme. The data obtained from Pre- and Post Tests, practical tasks, and exit questionnaires (closed questions) were used to conduct quantitative analyses to identify students' learning experience. Pearson's *r*, which is appropriate to analyse interval level data [21], was applied to find the correlations between students' individual differences and their learning preferences. A significance level of  $p < .05$  was adopted for the study. In addition, the mean scores are employed to describe the learning outcome for each individual group.

### 4.1 Overall Results

Table 2: The distribution of the participants

	Male (N=32)	Female (N=29)	Total (N=61)
<b>Computer Experience</b>			
None	0	0	0
Little	0	0	0
Average	9	11	20
Good	12	10	22
Excellent	10	9	19
<b>Internet Experience</b>			
None	0	0	0
Little	0	0	0
Average	12	10	22
Good	9	12	21
Excellent	10	8	18
<b>HTML Authoring</b>			
None	8	7	15
Little	9	11	20
Average	6	7	13
Good	8	5	13
Excellent	0	0	0

The participants (N=61) consisted of Masters' students at Brunel University's Department of Information Systems and Computing. Despite the fact that the participants were entirely self-selecting, in fact the sample is extremely evenly distributed in terms of gender, and system experience. They were 32 males and 29 females. The computer experience and Internet experience reported by the participants varied from average to excellence. Their familiarity with the subject content, HTML authoring, ranged from none to good (Table 2).

Table 3: Overall learning outcomes

	Post Test	Gain Score	Task Score	Task Time
Mean	10.4	7.7	6.5	46.5
SD	1.8	0.9	1.6	6.8

A majority of the students (78%) felt that the web-based instruction programme was useful and they liked the web treatment of the content. Their actual learning outcomes are described in Table 3.

#### 4.2 Tasks vs. Tests

As indicated in Section 3, students needed to be assessed by both practical task and paper-based tests. It is important to note that both task and tests were markedly different. The distinctions between both of them are similar to those between open-book examination and closed-book examination. The practical task was completed in "open book" examination style, with the students building their Web pages being guided by the task sheet. The practical task could be completed successfully without necessarily recourse to memory, by applying knowledge read from the screen at the particular time it was needed. On the other hand, the Post-Test, which was a multiple choice factual test, entailed recalling knowledge from memory, and completed after learning using the web-based instructional programme, looked like a closed-book examination. These differences can also be associated with those between procedural knowledge and declarative knowledge. Derry (1990) distinguishes between these two, procedural being "knowledge how", and declarative being "knowledge that" [3]. Procedural refers to knowledge of how to do things, while declarative refers to knowledge about the world and its properties [13]. Practical tasks refer to procedure knowledge of how to use HTML, while paper-based tests refer to declarative knowledge about the properties of HTML.

Table 4 Task Score and Prior Knowledge

Task Score		Internet Experience	HTML Authoring
Excellent	Mean	8.2	N/A
	SD	1.9	N/A
Good	Mean	6.9	8.4
	SD	1.6	1.8
Average	Mean	4.3	7.2
	SD	0.7	1.3
Little	Mean	N/A	6.0
	SD	N/A	0.7
None	Mean	N/A	4.2
	SD	N/A	0.3
Significance		r=.4400 p=.006	r=.3459 p=.036

Significant Pearson's correlations showed the students' task scores were affected by the levels of their previous Internet experience and HTML authoring

(Table 4). On the other hand, the Post-Test and Gain scores were positively influenced by their perceptions and attitudes toward the web-based instructional programme (Table 5). In other words, students who had more positive perceptions toward the web-based instructional programme could obtain better Post-test and Gain scores than those who had more negative attitudes toward the programme.

Table 5: Perceptions/attitudes & learning outcomes

	Post Test	Gain Score	Task Score	Task Time
Positive Perceptions	r=.4052 p=.013	r=.4601 p=.004	r=.2979 p=.073	r=.0856 p=.614
Negative Attitudes	r=-.0877 p=.606	r=-.1254 p=.460	r=.0548 p=.751	r=.3053 p=.066

It implied that performance on the practical task of applying procedural knowledge could be promoted by prior system experience in using Internet and HTML authoring, but it would not be affected by the matching or mismatching of instruction with students' preferences. Conversely, the ability to recall declarative knowledge appears to have been mainly facilitated by matching instructional presentation with learners' preferences, but it is not influenced by prior system experience of using Internet and HTML authoring.

#### 4.3 Gender Differences

Table 6: Gender Differences in Learning Outcomes

	Post Test	Gain Score	Task Score	Task Time
Female				
Means	12.4	9.3	4.5	35.5
SD	1.9	1.1	0.6	3.8
Male				
Means	8.5	6.2	8.6	56.4
SD	0.8	0.7	1.8	7.8
Significance	r=-.3519 p=.004	r=-.2889 p=.020	r=-.3374 p=.006	r=.3413 p=.005

The students' learning outcomes showed some interesting findings with regard to gender differences. Female students performed better than male students in the Post-Test. Conversely, male students outperformed female students in the practical task (Table 6). As indicated in Section 4.2, the differences between the Post-Test and practical task can be related with those between declarative knowledge and procedural knowledge. It implies that female students are better at acquiring declarative knowledge, rather than procedural knowledge. Conversely, male students are

skilled in gaining procedural knowledge, instead of declarative knowledge.

For learning attitudes, male students were patient in completing the task. On the other hand, female students felt nervous doing the tasks and some of them (N = 10) gave up doing the task in the middle stage. In addition, female students needed more guidance than male students. Female students tended to ask for instruction from the tutor, instead of trying to correct errors by themselves. These findings are in line with previous studies, which found that males showed more interest in using and learning about computers while females reported fear of using computers and feeling helpless around them [17, 9]. For this phenomenon, educators should help female students to build their confidence in facing the challenge of using computers, instead of giving too detailed instructions. In addition, educational settings should ensure that instructional programmes developed should not place any students at a disadvantage due to their gender differences [14].

#### 4.4 Prior Knowledge

Through analysing the students' prior knowledge, one thing seems evident. For doing the practical task, students who had greater experience of using Internet or HTML authoring seemed able to look for relevant information in an efficient way. Conversely, students who were lacking prior knowledge of the subject content needed more time to complete the task by using the web-based instructional programme (Table 7). It seemed that student's existing knowledge did influence their interaction with the web-based instructional programme. These findings arguably supported results from previous studies [18, 7] which found there was a positive relationship between learner control and prior knowledge.

Table 7: Prior Knowledge and Task Time

Task Time		Internet Experience	HTML Authoring
Excellent	Mean	39.2	N/A
	SD	5.5	N/A
Good	Mean	44.5	31.4
	SD	6.1	3.2
Average	Mean	54.4	41.9
	SD	8.1	4.3
Little	Mean	N/A	50.5
	SD	N/A	5.9
None	Mean	N/A	61.2
	SD	N/A	7.3
Significance		r=-.2690 p=.030	r=.2834 p=.022

Expert learners who had an adequate amount of prior knowledge on the subject felt familiar with the interface and the contents of the web-based instructional programme so they were confident about being more active when navigating the web-based instructional system. On the other hand, novice learners might not be aware of the best order to read the material or what the

most important information was. Therefore, it is important to provide novice learners with an initial phase of orientation relating to both interface and domain contents [12]. One of the ways is to provide visual paths, which can be displayed by means of cues to indicate how far students are along a path or by giving some conceptual description for the possible sequences. The alternative way is to providing good labels for the pages. Labels that clearly indicate the role of a particular page may help novices successfully to decide the appropriate coherent path [11].

#### 4.5 Learning by Doing

In this web-based instruction programme, students were asked to do a practical task (i.e. designing a web page with HTML). A significant number of students (44%) reported that doing the task was a useful way of helping their learning in the web-based instructional programme though they felt pressured by the whole process of doing the task. They thought that the task activities could help them set the focus and recall what they had learnt. From these 44% of students, 52% of them could obtain the Post-Test scores above the average (= 10.4) and 63% of them demonstrated more positive perceptions to the web-based instructional programme. These results implied that "learning by doing" could assist some students to set their effective learning strategies. As indicated by Smith and Parks (1997), tasks serve to simulate "goal directed" browsing in such a way that learning performance can be enhanced [20].

On the other hand, a few of them (30%) reported that doing the task hindered their learning. They found that they lost other important information that they needed to learn because they were concentrating on doing the task. From these 30% of students, 58% of them obtained the Post-Test scores below the average and 54% of them showed more negative attitudes toward the web-based instructional programme. This raises some interesting questions for further studies to consider (a) whether task activities can facilitate promoting students' learning performance in a web-based instructional programme; and (b) what the relationships are between students' attitudes and their learning patterns as reflected in a web-based instructional programme with/without setting tasks.

#### 5. Conclusions

The aforementioned findings provide evidence that web-based instructional programmes may not be suitable for all learners as an instructional methodology. Instructors must be aware of individual differences such as gender and levels of prior knowledge possessed. Some learners, e.g. novice learners, may need greater support and guidance from the instructors, while others may be able to follow web-based instructional programmes relatively independently. Thus, instructors should not assume that every student would benefit equally from web-based instructional programmes in

educational settings. There remains the need for guidance to ensure that all learners attain their learning potential.

Implementing web-based instructional programmes is a complex process composed of interactions among students, instructional content, and the features of web-based instructional programmes. It is important for educational settings to have a good plan in advance. Instructors should remain cautious about making a sweeping decision to convert entire curricula onto web-based instructional programmes. The goals of such a process should be weighed against the potential problems (e.g. alienating certain learners). To avoid alienating a certain group, instructors should continue to incorporate a number of different teaching strategies into their lectures. In addition, this transition requires time for the student and time in the classroom to acquaint the students with web-based instructional programmes. This is especially the case for students who have difficulties in independent learning; there is a need to let them have longer time for this shift. With this issue in mind, such innovation in teaching and learning will be more meaningful and valuable.

#### References

1. Burgstahler, S. (1997). Teaching on the net: What's the difference? *Technological Horizons in Education Journal*, 24, 61-64
2. Chen, S. Y. & Ford, N. J. (1998). Modelling User Navigation Behaviours in a Hypermedia-Based Learning System: An Individual Differences Approach. *International Journal of Knowledge Organization*. 25(3), 67-78
3. Derry, S. J. (1990). Learning strategies for acquiring useful knowledge. In B. F. Jones & L. Idol (Eds.), *Dimensions of thinking and cognitive instruction* (pp. 347-379). Hillsdale, NJ: Lawrence Erlbaum Associates.
4. Durfresne, A. and Turcotte, S. (1997). Cognitive style and its implications for navigation strategies. In B. Boulay and R. Mizoguchi (ed.) *Artificial Intelligence in Education Knowledge and Media Learning System*, p. 287-293, Kobe (Japan): Amsterdam IOS Press.
5. Ford, N. and Chen, S. Y. (2000). Individual differences, hypermedia navigation and learning: an empirical study. *Journal of Educational Multimedia and Hypermedia*. 9(4), 281-312.
6. Ford, N., and Miller, D. (1996). Gender Differences in Internet Perceptions and Use. *Aslib Proceedings*, 48, 183-92.
7. Gay, G. (1986). Interaction of Learner Control and prior understanding in computer-assisted video instruction. *Journal of Educational Psychology*, 78(3), 225-227.
8. Hedberg, J. G., and Corrent-Agostinho, S. (2000). Creating a Postgraduate Virtual Community: Assessment Drives Learning. *Educational Media International* 37(2), 83-90.
9. Koch, M. (1994). No girls allowed! *Technos*, 3, 14-19.
10. Lawless, K. A., & Kulikowich, J. M. (1998). Domain Knowledge, Interest and Hypertext Navigation: A study of Individual Differences. *Journal of Educational Multimedia and Hypermedia* 7, 51-69.
11. Lewis, C. & Polson, P. G. (1990). Theory-based design for easily learned interfaces. *HCI*, 5, 191-220.
12. Linard, M. & Zeillger, G. (1995). Designing navigational support for educational software. *Proceedings of Human Computer Interactions*. p.63-78
13. McGilly, K. (1994). *Classroom Lesson: Integrating Cognitive Theory and Classroom Practice*. Cambridge, MA: MIT.
14. Owen, M. B. & Liles, R. (1998). Factors contributing to the Use of Internet by Educators [Online]. Available: <http://outreach.missouri.edu/netc98/manuscripts/owen-liles.html>
15. Quintana Y. (1996). Evaluating the Value and Effectiveness of Internet-Based Learning [Online]. Available HTTP: [http://www.crim.ca/inet96/papers/c1/c1\\_4.htm](http://www.crim.ca/inet96/papers/c1/c1_4.htm)
16. Reed, W. M. & Oughton, J. M. (1997). Computer Experience and Interval-based Hypermedia Navigation. *Journal of Research on Computing in Education*. 30, 38-52
17. Shashaani, L. (1994). Gender differences in computer experience and its influence on computer attitudes. *Journal of Educational Computing Research*, 11(4), 347-367.
18. Shih, C and Gamon, J. (1999). Student learning styles, motivation, learning strategies, and achievement in web-based courses [On-line]. Available: <http://icel.wfu.edu/publications/journals/jcel/jcel990305/ccshih.htm>
19. Shin, E. C., Schallert, D. L. and Savenye, W. C. (1994). Effects of Learner Control, Advisement, and Prior Knowledge on Young students' learning in a hypertext environment. *ETR&D*, 42(1):33-46.
20. Smith and Parks (1997) Virtual hierarchies and virtual networks: some lessons from hypermedia usability research applied to the World Wide Web. Available: <http://ijhcs.open.ac.uk/smith/smith-nf.html> [12/04/1998]
21. Stephen, P. and Hornby, S. (1997). *Simple Statistics for Library and Information Professionals*. London: Library Association.

# Leveraging Enterprise-Wide Information System's Curriculum to Teach E-Business Concepts

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## Abstract

Many universities have struggled to incorporate Enterprise Resource Planning (ERP) systems into their Information Systems (IS) curriculum. They are now faced with the issue of how best to incorporate e-business. They often treat the two technologies separately without realising the synergy between the two. We propose that IS curriculum can be extended using an ERP system to teach e-business concepts.

Many IS departments have spent much time and resources in modifying their curriculum to incorporate Enterprise Resource Planning Systems. These systems are seen as a tool to reinforce many IS concepts. To facilitate the inclusion of ERP systems into the curricula universities have formed strategic alliances with major ERP vendors. The ERP vendor benefits from these alliances by increasing the supply of skilled graduates that can support their product thereby enhancing its marketability and lowering the cost of implementation, while the university gains access to the software at a greatly reduced cost. Through these alliances universities have made a commitment to incorporate ERP systems into their curriculum and have expended an enormous amount of effort and resources to achieve this. For many of these universities it is important to investigate how they can leverage their current level of expertise in ERP systems curriculum to incorporate many of the ERP's e-business functionality to support the teaching of e-business concepts. Many consider ERP systems as an essential component of any e-business strategy.

Before a university decides to build upon their existing ERP knowledge and resources to teach e-business concepts and skills in the IS curriculum, consideration should be given to a number of factors, including how e-business is covered in the IS curriculum at present; in what ways and to what extent should e-business issues be addressed; and what ERP resources should be extended to support the teaching of e-business concepts and skills.

This paper examines the potential use of ERP systems as a tool to teach e-business concepts. It discusses the different functionality available and its applicability to IS curriculum.

## 1. Introduction

Over a period of 40 years, the Information Systems (IS) discipline has become an essential component in the employment of information technology personnel in business and government organisations in Australia. IS curriculum has undergone rapid and continuous change in recent times. Since its inception as a discipline in tertiary institutions, IS curricula has undergone continual change. The function of IS now, is one of supporting innovation, planning and coordinating resources and systems, rather than one where specialists work in isolation. It has moved from processing data to providing an information infrastructure with applications aligned to organisational strategy [10]. Although it would not be possible to obtain universal agreement on the exact components, Information Systems is oriented towards business, involving the matching of information systems' requirements to an organisation's objectives. IS professionals, to be effective, require formal technical training and a "... sound educational foundation in their discipline so they can keep abreast of new technologies and be responsive to change" [12, p.219].

In recent times there has been concern, what only can be referred to as a panic as IS professionals are considering how to incorporate aspects of electronic commerce into IS curriculum. Initially there was a plethora of new subjects proposed which were primarily existing subjects with "e-" preceding the subject name. It was felt that many universities did this to gain a competitive advantage through the "first mover" principal. As academics began to grasp many of the new concepts of the e-world and their implications, the use of the term e-commerce was slowly replaced by the term e-business. E-business differs from e-commerce in that it relies on the integration of business processes and the supporting technologies to gain competitive advantage across the extended supply chain. It is more strategic in nature and requires greater skill sets than e-commerce due to the front-end back-end integration.

As an academic study, IS needs to educate students in the efficient and effective application of all components of an information system (computer hardware, software and people) to solve business and organisational problems. There have been a number of studies which have attempted to identify IS graduate skills and the resultant curriculum.

The IS'97 Model Curriculum [3] was a collaborative development between industry and academia. The model provided guidelines and resources to facilitate the development of quality undergraduate IS curriculum. Interestingly, this model curriculum, just four years old, makes little mention of electronic commerce or e-business. However the recent revision to this model curriculum (IS 2002) places far more importance on the role of e-commerce.

In the USA, the National Science Foundation [7] sponsored a task force of both industry and academic participants in an attempt to identify the IS skills relevant for the development and use of large information systems. The skills were categorised into Personnel Skills, Interpersonal Skills and Technical Knowledge and Skills. However even though the document acknowledged the importance of enterprise wide systems, it made failed to recognise the extension of these types of systems into the e-business arena and the skill requirements to support this extension. The resultant Information Systems-Centric Curriculum Document [7] recommended an inverted curriculum approach which allows students to experience and analyse real application systems from the beginning of their course [9]. This requires students to take greater responsibility for their learning with academics taking on the roles of mentors. An essential recommendation was the ongoing collaboration with industry to enable meaningful project activities, site experiences, case studies, and assistance in updating the curriculum.

In 2000 the U.S. Departments of Commerce, Labour and Education released the 21st Century Skills report designed to identify skills required by students to work in the "digital age". The report identified a number of broad generic skills but made little reference to specific IT skills [13].

The massive number of IT vacancies around the world, Australia 30,000 (Information Age, 1998), USA 200,000 and Germany 90,000 (The Australian, June 2000) have resulted in governments and industry conducting studies to identify the specific skill shortage areas [13] [2].

The Deloitte [4] report mapped E-skills into 9 super-types:

- Internet & multimedia,
- Application development,
- Web development tools,
- Operating systems,
- Internetworking,
- LAN administration,
- System software and support,
- Database management,
- Communications installation and maintenance.

The National Office of Information Economy reported that 37% of business identified lack of skills as a major barrier to business use of e-commerce [11].

The incorporation of e-business and related issues into university curriculum has been driven by a number of factors:

- Analyst's projections of the enormous growth in this market [1].
- Student's realisation of the potential lucrative job market.
- Industry looking for graduates with the appropriate skill set and
- Academics attempting to keep abreast of current issues in the information technology industry.

The challenge for IS academics is to modify their curricula to embrace the concepts of e-business as to provide graduates with the necessary skills to assist business enterprises in the future.

Many IS departments have spent much time and resources in modifying their curriculum to incorporate Enterprise Resource Planning Systems (ERP) [6] [8] [14]. These systems are seen as a tool to reinforce many of the IS concepts. To facilitate the inclusion of ERP systems into the curricula universities formed strategic alliances with many of the major ERP vendors [5]. The ERP vendor benefits from these alliances by increasing the supply of skilled graduates that can support their product thereby enhancing its marketability and lowering the cost of implementation while the university gains access to the software at a greatly reduced cost. One such alliance is the SAP University Alliance. Through these alliances, universities have made a commitment to incorporate ERP systems into their curriculum and have expended an enormous amount of effort and resources to achieve this. For many of these universities it is important to investigate how they can leverage their current level of expertise in ERP systems curriculum to incorporate many of the ERP e-business tools to support the teaching of e-business concepts. ERP systems are considered by many as essential component of any e-business strategy. This paper examines the potential use of ERP systems as a tool to teach e-business concepts. The paper will focus on SAP's ERP system as they are the market leader and have the largest university partnering program in the Australasian region.

## 2. SAP and e-Business

Since SAP's R/3 Release 3.1, a number of Internet-enabled applications via the inside/out approach have been made available. The Internet applications are developed to add a web user interface to existing SAP transactions. Since then SAP has offered more and more e-functionality especially in its more recent release, mySAP. SAP is now touted as the platform for many companies e-business strategy. Its various components support e-business through the intranet, business to consumer (B2C) and Business to Business (B2B) models. It does this from both a technical and business perspective. The relationships between these components can be summarised in Figure 1.

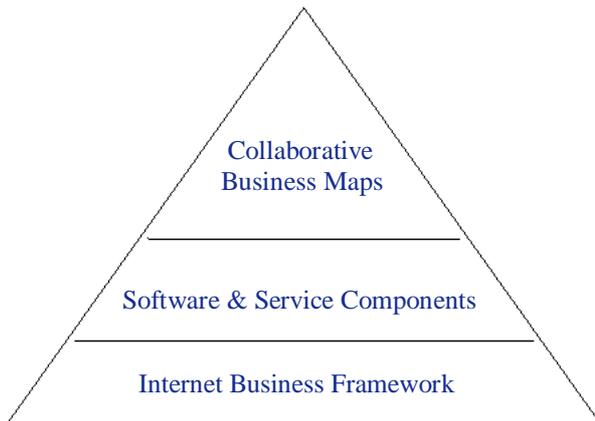


Figure 1: SAP e-functionality

The remainder of the paper will describe the various components contained in the ERP system and how they could be incorporated into an IS curriculum to teach e-business concepts.

### 3. Internet Business Framework

To support the evolving nature of software and particularly ERP systems, SAP developed its Business Framework. This framework facilitates the introduction of new software modules that are incorporated in the ERP system or new components that must interact with the system. This includes non-SAP software that must interact with the ERP system. The Business Framework enables open, integrated, component-based enterprise business application solutions to be produced. For example, using the Business Framework, a company's own IT systems could be coupled with those of customers and vendors. Customers can employ the Internet to shop—their Internet orders are transferred to the order management system and automatically executed through all the processing steps to delivery. Vendors can have access to specific parts of their customers' warehouse management systems, allowing them to independently schedule their deliveries.

The Business Framework adopts a top down approach utilising the following components:

- **Business Components.** These are defined encapsulated business functions such as modules (Human Resources, Logistics, Financials) and functional software (Business Warehouse, Knowledge Management).
- **Business Objects.** An object-orientated approach is adopted to define the objects involved in a particular business process such as customer and invoice.
- **Interfaces.** These provide an open access to business components via standard access methods. This is achieved via BAPIs (Business Application Programming Interfaces), which are the methods or functions assigned to each business object. BAPIs act like interfaces for controlled method calls between SAP business objects and objects of external providers. BAPIs are open interfaces to make certain that when two application systems communicate with

each other, the business-related information such as customer, order or part number, all uses the same semantics. BAPIs form the foundation of SAP's Internet strategy by providing an object-orientated interface between different business components.

- **Integration Technology.** SAP incorporates integration technology that supports industry standards such as CORBA, XML, COM+ and EDI to enable open access to SAP and non-SAP components.

BAPI's provide students, studying IS access to business data and processes following an object-oriented programming model. BAPIs can be called using object-oriented interfacing technologies, such as Microsoft's COM/DCOM (Component Object Model/Distributed Component Object Model), thus enabling software components from SAP and third parties to interact freely.

In addition BAPIs can be accessed from all development platforms that support the SAP Remote Function Call (RFC) protocol. For example, Microsoft's Visual Basic environment supports this protocol. As Visual Basic (VB) is frequently used as the programming language for introductory programming, students are able to use their VB skills as a conduit to accessing an object-oriented programming model within the Business Framework of SAP. For example, we set our students a programming task to write a VB application that incorporates BAPIs, to remotely log into our SAP system and retrieve customer information.

### 4. Software and Service Components

The software and services provided by SAP for e-business are primarily provided by Internet Application Components (IAC). Since SAP R/3 version 4 has contained more than 35 IAC's. An IAC defines a complete internet application consisting of a transaction from the ERP system and the corresponding HTML templates. Traditionally for a user to interact with SAP R/3 they required a reasonable level of training and expertise. This becomes a serious barrier when a company expects customers, potential clients, vendors, business partners and other employees to interact with the system as is the expectation with e-business. Through the use of IAC's, the HTML display is user-friendly and functional providing users with an easy-to-use interface.

IAC's can be broadly categorized into electronic retailing, customer service, purchasing, employee self service and internal services. The OnLine Store is an example of a supplied IAC. The Online Store is a business to consumer (B2C) solution provided to customers in a standard SAP system. It has all the standard features of many online shopping facilities. Its electronic catalogue interacts with SAP's sales and distribution module to display products, descriptions and inventory levels. The online store incorporates the standard "shopping cart" functionality for the identifying of goods to be purchased. It also incorporates various

payment methods for the purchasing of the goods in the shopping cart.

The OnLine Store facility in SAP could form the basis of an e-business curriculum. It enables students to determine and enter the master data which needs to be created to support the products which are to be included in their online store. They can design their product catalogue to display the products available through their store. It would provide students with an understanding of the business process used to support B2C transactions. They could track the placement of online orders sourcing, picking billing, delivery and changes in inventory levels. They can explore the accounting documents that are generated with this type of transaction. From a business perspective they can produce a variety of reports to demonstrate the performance of their store.

The OnLine store provides students with a practical understanding of the business concepts of B2C, students can also explore it from a technology point of view. The IAC's rely of SAP's Internet Transaction Server (ITS) to map SAP R/3 screens to a HTML format. It provides the necessary functional and performance characteristics required to execute R/3 transactions. The application logic remains within the R/3 system thereby providing an "inside-out" approach to e-business. Students in data communications units can use the ITS as a tool which can be configured. They can reinforce security issues, that they have covered, by using the firewalls and encryption capabilities of the ITS.

The architecture of the ITS supports the rapid development of web user interfaces for existing transactions and comes with a PC-based development tool ready for HTML template development - SAP@Web Studio. This development tool is well suited to users who have little technical background and are looking for a simplified way to create web applications. It operates, for the most part, in offline mode and requires almost no specific SAP knowledge. The newer version of SAP R/3 (4.6c) incorporates the Web Application Builder and has the advantages of an online development tool including repository access, reuse and navigation support. It allows for both the inside/out and the outside/in development styles that are used in building common web applications for SAP. Both these tools enable students to create their own applications based on the theoretical concepts they have covered.

At Victoria University we have a group of graduate students who are in the process of installing and configuring SAP's OnLine Store. Once installed this tool will be used throughout the Faculty to reinforce many of the e-business concepts taught in the various schools.

## 5. Collaborative Business Maps

SAP has developed collaborative business maps in an attempt to facilitate the transition of companies to an e-business environment. These maps define the activities, roles, system interfaces, and business documents required for business to business transactions using the ERP system. ERP vendors, in the past have argued that their

systems include "best business practice" and this claim applies equally in the e-world.

The business maps provide three different views of how a company can establish, implement and evaluate their e-business strategy:

- The Interaction View illustrates to companies how their business processes interact with their business partners' processes from an e-commerce perspective. It outlines which users should be involved and what business documents are exchanged.
- The Component View provides information on which technical aspects need to be installed to support the level of interaction as defined in the previous view.
- The Collaboration Scorecard provides a methodology to assess the return on investment for the ecommerce strategy.

The Business Maps provide a company with the necessary tools to develop, implement and assess their e-business strategy from a B2B perspective. This tool would be invaluable in a university setting. It would provide students with what is considered "best business practice" in the B2B environment. They would be able to examine the interaction of business processes between vendors and suppliers. They would become aware of the staff involved and the business documents exchanged. Also they would be exposed to the techniques used to determine return on investment of a B2B strategy. The collaborative business maps could be a foundation for e-business curriculum as they would provide an explanation of the main business processes and the necessary interactions. This teaching tool could be applied to e-business solutions in general.

Also available to students is the Solution Composer, which can be downloaded from the SAP web site free of charge. This tool enables students to modify existing business maps or compose new ones. By editing or creating their own maps, they can analyse and visualize the specific processes from case studies and discover how best to implement and support them in an e-business environment.

The e-business elements discussed above are relatively simple to incorporate into the IS curriculum. There are many other components that can also be used to reinforce e-business concepts but would require considerable effort to configure for student use. These include customer relationship management (CRM), mobile computing, e-procurement, employee self service and enterprise application integration functionality.

## 6. Conclusion

Many universities have struggled to incorporate ERP systems into their IS curriculum. They are now faced with the issue of how best to incorporate e-business. They often treat the two technologies separately without realising the synergy between the two. We have outlined how ERP systems curriculum can be extended to include e-business.

Before a university decides to build upon their existing ERP knowledge and resources to teach e-business concepts and skills in an IS curriculum, consideration should be given to the following questions:

- How is electronic business covered in the IS curriculum at present?
- If electronic business issues are to be addressed, then in what ways and to what extent should this be done?
- Can our existing ERP resources be extended to support the teaching of e-business concepts and skills?

## References

- [1] Bermudez J., Kraus B., O'Brien D., Parker B., and Lapide L., (2000) The Report On E-Commerce Applications, AMR Research.
- [2] British Computer Society. (2000), The British Computer Society Review 2000: Computing in the 21<sup>st</sup> century, located at [www.bcs.org.uk/review/2000](http://www.bcs.org.uk/review/2000) accessed January 2002.
- [3] Davis, G., et al., (1997), "IS'97: Model Curriculum and Guidelines for Undergraduate Degree Programs in Information Systems", ACM and AITP: USA.
- [4] Deloitte, Touche, & Tohmatsu, (1999), "Future Demand for IT&T Skills in Australia 1999-2004, IT&T Skills Workforce, A Report Developed for the Australian Government", as reported in [www.noie.com.au](http://www.noie.com.au), accessed May 1999.
- [5] Hawking, P. (1999), "The Teaching Of Enterprise Resource Planning Systems (Sap R/3) In Australian Universities." Proceedings of the 9th Pan Pacific Conference, Fiji.
- [6] Hawking P., Shackleton P., Ramp A., (2001), "IS' 97 Model Curriculum and Enterprise Resource Planning Systems" Business Process Management Journal, Vol. 7, No.3.
- [7] ISCC99 Information Systems Centric Curriculum located at <http://www.iscc.unomaha.edu> accessed on January 2002.
- [8] Lederer-Antonucci Y., (1999), "Enabling the business school curriculum with ERP software experiences of the SAP University Alliance", Proceedings of the IBSCA'99, Atlanta.
- [9] Lidtke, Doris K., Gordon E. Stokes, Jimmie Haines and Michael C. Mulder (eds), (1999), "ISCC'99, An Information Systems-Centric Curriculum'99 Program Guidelines". URL <http://www.iscc.unomaha.edu> accessed March 20<sup>th</sup> 2001.
- [10] Longenecker, H.E.J., D. L. Feinstein, et al., (1994) "Information Systems '95: A Summary of the Collaborative IS Curriculum Specification of the Joint DPMA, ACM, AIS Task Force", Journal of Information Systems Education, Winter: p. 174-186.
- [11] NOIE 2000, (2000), The Current State of Play: Australia and the Information Economy located at [http://www.noie.gov.au/projects/information\\_economy/research&analysis/index.htm](http://www.noie.gov.au/projects/information_economy/research&analysis/index.htm) accessed January 2002.
- [12] Richards, R.M. and C.C. Sanford, (1992), "An Evolutionary Change in the Information Systems Curriculum at the University of North Texas". Computers & Education, 19(3): p. 219-228.
- [13] Stuart, L., (1999), "21st Century Skills for 21st Century Jobs", US Department of Commerce, January 1999, as located at [www.vpskillsummit.org](http://www.vpskillsummit.org), accessed August 2000.
- [14] Watson, E. and H. Schneider, (1999), "Using ERP Systems in Education". Communication of the Association for Information Systems, 1(9).

# An Empirical Study of Knowledge Creation and Interaction in Argumentation Setting

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## Abstract

The paper defines Computer-Supported Collaborative Argumentation as a collaborative activity supported by CMC, which focuses on argumentation interactions. CSCA embeds the advantage to eliminate social context cues and provides a direct channel to express one's opinions. In this case, Computer-Supported Collaborative Argumentation (CSCA) becomes a new paradigm supported by Computer-Mediated Communication. CMC facilitates a context for participants within argumentation interactions that embed the advantages of computer conferencing. The goal of our research is to analyse the relationship between knowledge creation and quality of interaction and quality of discussion within an argumentation process. We report data of an experiment in which 120 MIS 2<sup>nd</sup> years students use four communication media settings on knowledge creation. The results suggest that an argumentation-based approach provides an environment not only for creating but also for motivating a community-wide view of information sharing because it enables discussion, mutual engagement and autonomy of knowledge exchanging. Also, in contradiction to media richness theory, this study indicates that structured argumentation-based software results in a better quality of argumentation interaction within the team, and more favourable attitude and participation in interaction, and thus yields the highest level of knowledge creation among four different communication configurations (including face-to-face).

Keywords: Argumentation, Knowledge creation, CSCA, Toulmin, SECI

## 1. Introduction

This empirical study reports the considerations which have to be taken into account in order to understand the

relationship between knowledge creation and communication configurations. Recently, Computer-Supported Collaborative Argumentation (CSCA) becomes a new paradigm of virtual learning and knowledge creation. CSCA is supported by Computer-Mediated Communication (CMC), since CMC facilitates a context for participants within argumentation interactions; in this case, CSCA embeds the advantages of computer conferencing. There are many studies focus on knowledge management but not many detail in knowledge creation neither the influential factors of knowledge creation. Nonaka and Takeuchi [10] state that there are four types of knowledge transformation, in order to achieve the successful outcome of four types of knowledge transformation, participants have to participate in collaborative activity enthusiastically. Due to CSCA embeds the advantage to eliminate social context cues and provides a direct channel to express one's opinions. From knowledge creation aspect, it is possible to infer that because the individual externalises his/her existing knowledge and internalises different opinions and comments from argumentation stimuli, the processes trigger knowledge transformation and knowledge creation. This research attempts to verify in general to understand the relative effects of four communication configurations: face-to-face, email and automated argumentation facilitator software and self study., and in particular the relationship between knowledge creation and argumentation.

## 2. Development of Research Model

Epstein [7] argues that in knowledge sharing, communication skills are more relevant than types of knowledge. In this context, the channels of communication may dominate the processes of knowledge sharing; they may influence knowledge transformation and knowledge creation. In order to

investigate issues relevant to argumentation-based knowledge transformation, the present research seeks answers to the following questions:

1. How does a collaborative argumentation-based setting help or hinder knowledge processing?
2. How does Computer Supported Collaborative Argumentation System (CSCA) help or hinder knowledge processing?
3. Is the CSCA model effective for creating knowledge?
4. How can an Automatic Argumentation Facilitator (AAF) in CSCA model help or hinder knowledge transformation?
5. How effective is the support provided by the Automatic Argumentation Facilitator?
6. What is the relationship between knowledge transformation types and knowledge creation?
7. Which type of knowledge transformation has the most impact on knowledge creation?

We identify *subject knowledge*, *argumentation interaction quality*, *knowledge interaction quality*, *motivation and participation*, *problem solving ability*, and *knowledge transformation types* as the dependent variables. With the characteristics of these variables, we explore the influence of this combination of variables within numbers of combinations of different interaction models, different communication treatments and different argumentation structures. Therefore, we identify *interaction model (argumentation vs. without argumentation)*, *Communication treatment (Traditional vs. CSCA)*, and *argumentation structure (structured vs. unstructured)* as independent variables. Damon [5] states that it is important to know the impact of interaction settings on the individuals. In the present study we look into the effectiveness of different combinations of independent variables as well as the effectiveness within different combinations of independent variables. The former focuses on social, meta-cognitive and the outcome results, for example, subject knowledge and problem solving ability. The latter emphasises the interactions in the processes such as knowledge interactions quality, argumentation interaction quality, and the transitions between different knowledge types. We chose a pre-test/post-test design in order to know how altering the combination of variables changes the outcomes.

However, researchers suggest that when we try to obtain deep understandings of information technology and its uses it is not sufficient just to focus on outcomes; we must also study the processes and interactions within the research [4][5][11]. This study selects quantitative approaches to analyse and categorise unstructured arguments (Email) and structured arguments (F2F and AAF) within the processes.

In Figure 1 we illustrate the experimental configuration, **Self-study** indicates a configuration without argumentation setting; **Email** indicates an unstructured computer-supported collaborative

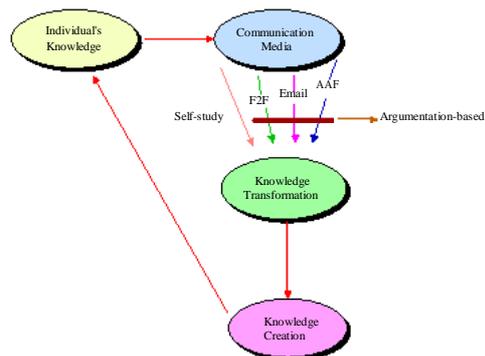


Figure 1. Research Model

argumentation configuration; on the other hand, **AAF** indicates a structured computer-supported collaborative argumentation configuration (automated argumentation facilitator software); and **F2F** (face-to-face) indicates a structured conventional collaborative argumentation configuration. In this experiment we use “structured” to suggest that argumentation interaction applies Toulmin’s model, that is, the participants have to issue their claims followed by the data and the warrant.

According to Media-Richness Theory (MRT), task performance can be improved when task information processing requirements are matched with a medium’s ability to convey information richness (Daft and Lengel, 1984). Face-to-face is considered as the richest medium; it has great potential for carrying information (e.g. emotional, attitudinal, and normative), and is recommended for resolution of an equivocal situation (e.g. negotiation). A lean medium (e.g. a text-base or memo) is always used to exchange unequivocal messages.

Based on McGrath and Hollingshead [8], a CSCA system can be considered a moderate media richness medium between text-base and face-to-face. It is the best fit to intellectual tasks. In this study groups are designed to work in different settings: Self-study, F2F, Email and the AAF system. The principal research framework and relationships from the literatures is shown in Figure 1. The correlation between dependent variables and independent variables is depicted in Figure 2.

### 3. Hypotheses

Computer-Supported Collaborative Argumentation (CSCA) is an avenue for achieving conditions for knowledge creation. For example, because of the advantages of reducing the social anxiety of CMC, individuals may experience less apprehension and may be more willing to share their experience (tacit knowledge). Once individuals are willing to share their knowledge source, collected intelligence is fulfilled. We claim that CSCA facilitates the process of eliciting the knowledge, elaborating the knowledge, amplifying the knowledge and justifying the knowledge. We use this concept to investigate the hypothesis that collaborative argumentation is an approach to the improvement of knowledge transformation; an automatic argumentation

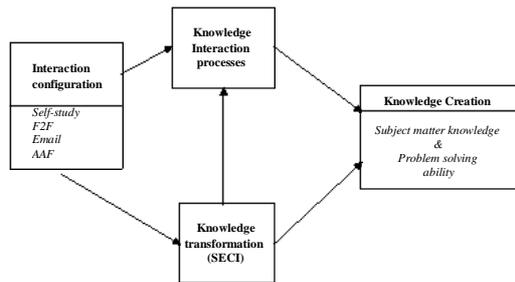


Figure 2. Correlation between dependent and independent variables

facilitator (AAF) in computer-supported collaborative argumentation (CSCA) facilitates a better result of knowledge transformation; the differences in communication configuration influence the type of knowledge transformation, thus affecting knowledge creation.

In order to investigate how different configurations affect subject matter knowledge, three hypotheses were established and tested.

**Hypothesis 1:** Participants in an argumentation-based process acquire more subject matter knowledge compared to the participants without an argumentation-based setting.

**Hypothesis 2:** Participants in a CSCA model acquire more subject matter knowledge compared to the participants in a traditional argumentation-based setting.

**Hypothesis 3:** Participants in a structured CSCA argumentation environment acquire more subject matter knowledge compared to the participants in an unstructured CSCA environment.

One of the potential advantages of CMC is that it allows the application of a spectrum of structured and unstructured techniques and methods to perform a task. We designed two CMC communication configurations in our experiment: the Email setting and the AAF system. The main difference between the AAF system and the Email system is that the Email system is an unstructured argumentation environment; individuals can articulate their opinions and arguments in a text-based format without any style limitation. On the other hand, the AAF system is a structured argumentation context, which provides graphic representation of arguments. Whilst individuals externalise their arguments they have to follow Toulmin's argumentation model. There are a number of advantages of the AAF system setting over the Email setting. Firstly, the AAF system facilitates an argumentation structure. It fosters an environment to direct participants through a sequence which aims to reach consensus. Secondly, the AAF acts as a neutral third party or referee. It provides support for group dynamics, such as maintaining the agenda of argumentation. Moreover, according to certain rules or algorithms, the AAF system manages the conflict and evaluates the strengths of the

arguments. Further, the AAF system can limit the amount of non task-related talk hence it improves argumentation efficiency. Finally, with synchronous WYSIWIS feature, the AAF system presents the arguments in graph structure to both parties spontaneously, it stimulates participants creating as a result a high quality of knowledge interactions. With these advantages we establish the following hypotheses to justify our investigation.

**Hypothesis 4:** Participants in a structured CSCA argumentation environment have a better quality of argumentation interaction compared to the participants in an unstructured CSCA argumentation environment.

**Hypothesis 5:** Participants in a structured argumentation environment have a better quality of knowledge interaction compared to the participants in an unstructured argumentation environment.

**Hypothesis 6:** Participants in a structured argumentation environment have a better perception and higher participation compared to the participants in an unstructured argumentation environment.

Based on the elimination of non task-related talk and the prescribed sequence of process, Hypothesis 7 examines the problem-solving ability in different argumentation-based settings.

**Hypothesis 7:** Participants in a structured CSCA argumentation environment acquire more problem-solving ability compared to the participants in an unstructured CSCA argumentation environment.

## 4. Methodology

**Subjects.** The participants in the experiment were 120 2<sup>nd</sup> year students at the university majoring in management who enrolled on the course in Management Information Systems. The experiment is incorporated into a four weeks workshop which delivers the topic related to the Groupware concept, the participants are required to attend the workshop once a week. The participants are told that the subject knowledge in the workshop will be included in the final examination, and the performance in the workshop is also counted as a partial credit of the final mark. Two groups of 60 students are formed: the treatment group in which, in the argumentation-based model, members are asked to elaborate their arguments within the experiment; and the control group that relies solely on self-study. The group in the argumentation-based setting is further divided into three sessions; each session has 20 students who participate in different settings. According to this design there are four sessions in the experiment: (1) session one neither computer-supported nor argumentation-based model (self-study), (2) session two is an argumentation-based model with traditional F2F (face-to-face) interaction, (3) session three is an unstructured CSCA environment (Email), and (4) session four is a structured CSCA environment (AAF).

**Experimental Task.** The participants in the argumentation-based sessions were asked to perform a collaborative problem solving and decision-making task. It involves ranking 15 desert survival items in a simulation of a desert survival situation [9][2]. We used “The lost kingdom of the Sahara” as the title of the experiment. The desert survival simulation describes a group of four archaeologists who encountered the challenge to rank 15 salvaged desert survival items in the desolate region of the Sahara in the middle of summer (where their plane has crashed). To further understanding, the experiment provides a URL containing the scenario of the task, desert survival knowledge from desert survival experts, and useful dynamic web links, which are relevant to the workshop.

Moreover, the Web page also includes details of the experiment and instructions on how to use the AAF system. The reasons to choose such a task are because (1) the task is open-ended problem solving, (2) the task is “light” to every participant without much “heavy” knowledge, (3) the task embeds an interesting competitive game which can provoke argumentation, (4) the task stimulates participants to search for more information in order to support their arguments, (5) the task requires higher-order skill (analysis, evaluation, synthesis) and deep elaboration, and (6) the task facilitates collaborative learning and collaborative argumentation.

Many studies [6][3][1] show that collaborative problem solving is one of the most effective paradigms to promote learning. We hypothesize that the task has the advantages of provoking argumentation, supporting critical thinking and exploring multiple perspectives which trigger knowledge transformation and enhance knowledge creation.

**Procedure.** The total experimental duration is five weeks; the first meeting takes place before the workshop begins. In the first meeting participants are introduced to the concept of CMC and Groupware as well as the schedule of the experiment and desert survival simulation. A form, which includes a list of 15 desert survival items, is distributed to the participants, and participants are asked to rank the order of survival items within 35 minutes. The forms are collected at the end of the meeting and marked according to the “experts’ ranks”. Participants are required to practice the materials on the Web page, which is designed for the desert survival situation simulation workshop. The Web page contains the details of the experiment, CMC and Groupware concepts, desert survival knowledge, Toulmin’s model and the instructions of how to use the AAF system.

We conclude this section with the summary of research procedure:

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- Step 1. Provide desert survival kits ranking form to all the participants.
  - Step 2. Participants rank the survival kits and return the form to the instructor.
  - Step 3. The form is marked according to “experts’

ranks”.

- Step 4. Introduce Groupware concept, Toulmin’s model and the AAF system.
  - Step 5. Participants access the Web page to practice using the materials which are relevant to the desert survival situation simulation workshop.
  - Step 6. Tutoring session for the AAF system and Toulmin’s model.
  - Step 7. Participants engage in experiment under different communication configuration.
  - Step 8. Participants complete problem-solving ability ranking form according to their communication configuration.
  - Step 9. Participants fill the post-experimental questionnaire individually.
  - Step 10. Data collection and analysis.
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**Data Collection.** The primary methods of data collection in the present study are; post-experimental questionnaire; problem-solving ability test (desert-survival items ranking); and transcripts of argumentation. The main reason for these methods is because the major part of the study is concerned with the perception of the different communication configuration in argumentation, interaction within the argumentation, and how these perceptions and interactions affect knowledge transformation and further knowledge creation. Pre-test of problem-solving ability can provide the sketch of an individual’s desert survival ability. For the argumentation-based/self-study group, post-experimental questionnaire measures desert survival knowledge, perception of the activity and the interaction within argumentation. Post-test of problem-solving ability assesses the desert survival ability after experiment on a team basis (argumentation-based) or individually (self-study), it presents the strength of collaborative argumentation in different communication configuration.

## 5. Findings

In this study, the participants collaboratively generate the knowledge for problem solving, and then apply the knowledge which they explore from interaction; the score of problem-solving ability is the representation of knowledge application. Of the 120 university students majoring in MIS as study participants, most participants completed their post-experimental questionnaire; but more than half of participants in argumentation-based setting were unable to complete their whole discussion of desert-survival items ranking because of time constraints. However, final valid data in this study is 62: 36 from Self-study group, 8 from face-to-face group (dyads), 10 from the Email group (5 dyads), and 8 from the AAF setting. The data are used to test ten research hypotheses.

The study explores knowledge processing in argumentation-based setting; furthermore, the study investigates the influences of the automatic argumentation facilitator in knowledge transformation and knowledge

creation. From data analyses, we summarise the findings related to each research hypothesis.

Hypothesis 1. We had hypothesized that an argumentation-based setting would be positively associated with subject knowledge gain, but the result shows no support for our hypothesis. The participants in Self-study have a higher mean of subject knowledge compared to the participants in a face-to-face and the Email system and this implies that collaborative argumentation does not guarantee better subject knowledge as a result. Many factors have to be considered in the activity. For example, communication medium selection, time arrangement, dyads arrangement and task characteristics. The fact that the AAF system facilitates diagrammatical argumentation features in the process could be a factor explaining the highest subject knowledge gain.

Hypothesis 2. With information technology, it is reasonable to hypothesise that the participants in the CSCA model gain higher subject knowledge compared to the participants in the traditional model. The data analysis supports our expectation. We found that the participants in the face-to-face setting perceive some degree of social contextual cues, this may affect the motivation in argumentation activity.

Hypothesis 3. As Hypothesis 1, we expect that with computer supported well formatted and well structured process design, participants may acquire more subject knowledge, since the AAF system can provide suitable features to facilitate the argumentation process. The result supports our hypothesis but the result is not significant.

Hypothesis 4. In a structured CSCA environment, participants experience higher motivation and comfort when they use the AAF application, on the other hand, the participants in an unstructured CSCA environment may perceive it to be laborious and cumbersome thus decreasing the quality of argumentation interaction. The data supports our hypothesis but the result is not significant.

Hypothesis 5. Quality of knowledge interaction is one of the important variables in the knowledge process; we hypothesized that the participants in a structured argumentation environment should have better quality of knowledge interaction. The data analysis does not support our expectation. We infer that the relationship between argumentation moves and the communication medium is an important factor; the participants in a structured argumentation environment may perceive constraints while they express their thoughts. For example, in the AAF system, the participants have to follow Toulmin's model to articulate their arguments and in a face-to-face setting, participants perceive some degree of socially contextual cues while they present their opinions.

Hypothesis 6. In a structured argumentation environment, participants may perceive effectiveness of learning in argumentation, and thus may provoke motivation in the activity. The data analysis support this hypothesis but there is no significant result.

Hypothesis 7. The relationship between problem-

solving ability and structured/unstructured CSCA settings is supported and is statistically significant. The data analysis yields an interesting finding that a good quality of argumentation interaction may promise the better outcome of problem-solving ability in negotiation types of task. Even the participants in the Email system have a good quality of knowledge interaction, but they acquire the lowest problem-solving ability score, and this may imply that engaging in argumentation does not necessarily result in good problem-solving.

## 6. Conclusions

We compared the means of subject knowledge, quality of argumentation interaction, quality of knowledge interaction, and the perception and participation between a structured argumentation-based software environment and a traditional argumentation-based environment. We found that the participants in the structured argumentation-based software environment have higher subject knowledge gain, higher quality of knowledge interaction, and higher perception and participation but lower quality of argumentation interaction compared to the participants in the traditional face-to-face argumentation environment. The data reveal that with the advantages of information technology participants experience easy articulation of their arguments and this increase in terms of subject knowledge. The results of this study indicates that the participants in a face-to-face interaction have the highest score of problem-solving ability, and participants in self-study have the second highest score of problem-solving ability.

The task for participants in this study is an open-ended problem-solving task; it can be categorized as a negotiation conflict-of-interest task, and therefore, the face-to-face communication model is the best fit to the task (according to Hollingshad *et al.*, [8]). The results support media-richness theory (MRT) which suggests that if task information processing requirements are matched with a medium's ability to convey information richness then this can improve task performance.

## 7. References

- [1] Baker, M. 1992. Modelling negotiation in intelligent teaching dialogue. In M. ElsomCook & R. Moyse (Eds.), *Knowledge negotiation*, 199-240. London: Paul Chapman Publishing.
- [2] Balthazard, P.A. 1999. Desert Survival Situation-Internet Edition. Available at <http://consensus.west.asu.edu/dss115>.
- [3] Burnett, R. E. 1993. Decision-making during the collaborative planning of co-authors. In A. Penrose & B. Sitko (Eds.), *Hearing ourselves think: Cognitive research in the college writing classroom*. 125-126. NY: Oxford University Press.
- [4] DeSanctis, G. and Poole, M.S. 1994. Capturing the Complexity in Advanced Technology Use: Adaptive Structuration Theory. *Organization Science*. Vol. 5, No 2, 121-147.

- [5] Damon, W. 1991. Problems of direction in socially shared cognition. In L. B. Resnick, J. M. Levine, & S. D. Teasley. *Perspectives on socially shared cognition*. 384-397. Washington: APA.
- [6] Erkens, G. 1997. *Co-operative problem solving with computers in education: Modelling of co-operative dialogues for the design of intelligent educational systems*. Utrecht, The Netherlands: Brouwer Uithof.
- [7] Epstein, L. D., 2000. Sharing Knowledge in Organization: How people use media to communicate. *Unpublished doctoral dissertation, University of California, Berkeley*.
- [8] Hollingshead, A. B. McGrath J. E., O'connor, K. M. 1993. Group task performance and communication technology: a longitudinal study of computer-mediated versus face-to-face work groups. *Small Group Research*, 24 (3), 1993, 307-333.
- [9] Human Synergistics, 1987. *Desert Survival Situation*. Plymouth, MI: Human Synergistics.
- [10] Nonaka, I., and Takeuchi H., 1995. *The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation*. NY: Oxford University Press.
- [11] Nunamaker, J., Dennis, A., Valacich, J., Vogel, D., and George, J. 1991. Group Support Systems to Support Group Work. *Communications of the ACM*, Vol. 34, No 7, 40-61.

# A Study on Using Internet to Implement Constructivist Scaffolding Teaching for “Research Method” Course

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## Abstract

“Scaffoldings” states to let teachers provide a temporary support to help the students developing their self-scaffolding, this temporary support (the scaffolds) might be a kind of teaching facility or teaching strategy, as the capability of the learner advanced, the learning responsibility will shift gradually to the student, finally the student can dominate his/her learning, and through learning he/she shall build up his/her own knowledge. In this study, Internet and the Constructivist Scaffolding Teaching Theories are applied to develop a teaching model based on the “Research Method”- a program for the first year in graduate school, so that information technologies can be applied to make up the teachers’ deficiencies in terms of energy, time and capability. On the other hand, taking the advantages of the traditional teaching model face-to-face communication, and interaction to make up the deficiencies of Internet teaching. To realize the effects of this instructional model, experimentation is adopted in this study. Differences of learning results between constructive scaffolding teaching model with Internet assistance (CSTMIA) and the traditional teaching model (TTM) are analyzed.

The result of the study shows: (1) indeed the performance of the CSTMIA better improves the students’ learning achievement than that of the TTM, but it is not as good as the traditional teaching in terms of the learning performance, learning satisfaction and the growth of learning capabilities; (2) the result of the subsequent evaluation and analysis shows: based on the subjective realization from more than 60% of the students in the CSTMIA, they are positive toward the capability of such CSTMIA in the improvement of learning performance, learning achievement, learning satisfaction, interaction between teachers and the students, and the growth of learning capabilities, this proves that the CSTMIA implemented by this study helps improve the learning effect, strengthen the interaction between teachers and the students in certain extent. The contributions of this study are: (1) Based on the “Research Method” program, to develop that program’s Constructivist Scaffolding Teaching Model supplemented by Internet; (2) Based on the “Research Method” program, to see the influences of the Constructivist Scaffolding Teaching Model supplemented by Internet toward the learning performance, learning achievement, learning Satisfaction, interaction between teachers and

the students, and the growth of learning capabilities.

Key words : Scaffolding theory; Internet; Learning performance; Learning Satisfaction ; The growth of learning capabilities

## 1. Introduction

With the rapid development of technologies, computers can apply in wider areas than before. More and more people use computers on teaching for its convenience of two-way communication, vivid and vigorous media. They hope it can replace the single and dull traditional teaching environment. Moreover, bring about interests of learners to increase their learning effects. This kind of teaching activity with Computer-Based Training is becoming a pedagogical trend (Davis & Davis, 1990). In this study, a teaching model is developed with Internet and constructive scaffolding (CSTMIA) to tie it in the “Research Method” - a program for the first year in graduate school. On the one hand, information technologies can be applied to make up the teachers’ deficiencies in terms of energy, time and capability. On the other hand, taking the advantages of face-to-face communication and interaction of the traditional teaching model to make up the deficiencies of Internet teaching.

The developing technologies change the ways of learning and teaching. New teaching techniques should match up new teaching methods to emerge its specialty. The newly web-based instruction is a modern paradigm about applying new teaching media. Alavi (1995) addressed that use information technologies can increase added value of courses, enhance learning effects of learners, improve the effects of collaborative learning and teaching, and lower teachers’ loading and total teaching cost. Furthermore, students can be provided more integrated and richer learning contents.

Owing to information techniques highly developing and popularizing quickly, it made a great impact on recent education. To strengthen learning effects of traditional teaching and supplement the weakness of lacking face-to-face interaction in web-based instruction, many teachers and scholars believed information technologies can promote education innovation and renovate traditional teaching (Dexter, Anderson, & Becker, 1999; Dias, 1999). Computer integrated instruction and technology integration are often applied

to highlight the importance of teaching with information technologies integrated (Dias, 1999; Ertmer, Addison, Lane, Ross & Woods, 1999). Apply information technologies to curriculums and classrooms are discussed and it was regarded as a critical topic for curriculum integration with technologies. Many researches show that when implementing teaching with information technologies integrated, patterns and types of teaching will change (Dexter, Anderson, & Becker, 1999; Dias, 1999).

In recent years, computers play important roles in teaching for the advanced hardware and software. It also brings about many impacts on traditional teaching model. At the same time, it drives many studies toward distance teaching with the Internet. Scaffolding learning theories are usually discussed the learning effects in elementary and secondary school, or special education in Taiwan. Up to now, studies of learning effects are short of discussing scaffolding learning theories integrated information technologies for specific courses of university level. However, there have been successful researches brought up in other countries in this field (Kao, Lehman, 1997; Oshima & Oshima, 1999; Kao et al, 1996; Weston & Barker, 2001). Based on the mentioned background, applying Internet and ITs as teaching in universities has been gradually shaping. Internet teaching would be applied wider and wider in the future. The functions shall have more flexibilities and variety. The purpose of this study is to discuss and analyze the effects of CSTMIA for learning the Research Method course in graduate school. Teaching activities are designed under the foundation of scaffolding teaching theories. Analyses of teaching effects are preceded after the actual teaching programs, and then CSTMIA is also established.

According to the findings of relevant researches about scaffolding teaching theories, which would indeed improve learning effects. Hence, the purpose of this research does not lie in validating the scaffolding teaching theories. Instead, if learning effects can be enhanced by CSTMIA is the most concern and important discussion in this study. Therefore, there are several objectives would be achieved:

1. Focus on the course of "Research Methods", the constructive scaffolding teaching model is developed with Internet assistance (CSTMIA).
2. Discuss the differences of learning performance, learning satisfaction, interaction between teacher and students, and the growth of learning capabilities between CSTMIA and TTM.
3. Determine that if CSTMIA strengthen more than TTM in aspects of learning performance, learning satisfaction, interaction between teacher and students, and the growth of learning capabilities.
4. Analyze the influences of teachers' loadings as applying Internet on teaching.

## 2. Literature Reviews: Scaffolding Teaching Theories

Any pedagogical approach would have its own

theories basis and background. Scaffolding teaching theories is derivated from the sect of cognitive psychology; what is more, constructionism and collaborative learning are derivated as well form the same domain. Many relevant researches have proved that scaffolding teaching theories is helpful on promote learning effects. Wood et al. (1976) propose the term of scaffolding in 1976 and its main meaning is: growth of learner's psychological abilities rest on assistance from instructors or high-abilities peers, and this kind of assistance should ground on the learner's organization properties of cognition thereupon. Wood et al. (1976) also summed up six supports that scaffolding can offer: 1. Provoked students' learning, 2. Figured out key characteristics of learning objects, 3. Provided relevant examples for students to inspect and learn, 4. Lightened learning loads, 5. Managed directions of learning activities, and 6. Controlled the discouragement in learning process.

The basic concepts of scaffolding originated from the learning theories proposed by the Russian psychologist Vygotsky. He considered that social meanings and experiences of human cognition development process are transformed in personal and inherent meanings with the steps of innerize or action movements (Vygotsky, 1962). Vygotsky divided the levels of cognition development into real level of development and potential level of development. The former means the level that individuals can solve problems independently; the latter means the level that individuals only can solve problems with guidance or collaboration of others (instructors or high-abilities peer). The difference or gap between these two levels has been named zone of proximal development (ZPD) by Vygotsky (1978).

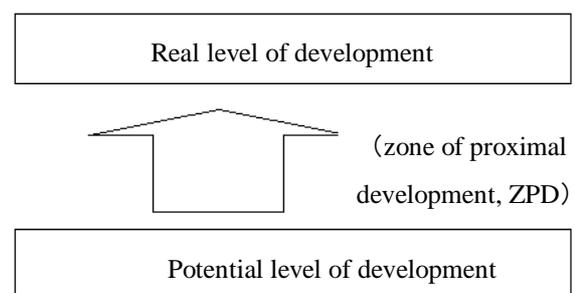


Figure 1: Scaffolding- Zone of proximal development (ZPD)

Scaffolding theory is founded on the concept of ZPD advocated by Vygotsky. Dynamic assessment in teaching, social interactions between learners, and learner's introspection progress are emphasized in this theory. Scaffolding proposes a temporary support to assist students developing their learning capabilities. This temporary support (the scaffolds) might be a kind of teaching facility or teaching strategy, as the capability of the learner advanced, the learning responsibility will shift gradually to the student, finally the student can dominate his/her learning, and through learning he/she shall build

up his/her own knowledge. Therefore, ZPD is regarded as one type of transfer of responsibility in learning processes (Rogoff & Gardner, 1984). Three important conceptions of scaffolding can be summed as follows:

1. In the ZPD, scaffolding supplier (teachers) and receivers (students) have mutually beneficial relationships. The mutually beneficial relationships mean that learning supports of teachers and interaction feedback of students should be decided via negotiation with each other.

2. Teachers ought to gradually shift learning responsibilities to learners, and when is the suitable time will depend on the actual learning states.

3. Communication between teacher and students is the approach that help learners introspect and cognize.

The final purpose of teaching by scaffolding is to achieve learning shifts and self-oriented learning for learners. It would assist learners in developing self-scaffolding for learning. Bickhard (1997) considered that when the scaffolds are defined as simplifying learning background (decrease obsession of choosing) and giving extra supports (guidance of choosing), that will make learners do wise learning. In this moment, learner's self-scaffold is defined that learner can integrate his/her learning content, make extract, and choose it. He/She can also look for outside resource (supports) at the same time. Several points can be concluded as below:

1. Transfer of responsibility: Teaching by scaffolding emphasized that the transfer of teaching will be gradually shifted from instructors to learners.

2. Dialogue of teaching: dialogues in learning progress are strongly stressed, which included instructors to learners and learners to learners.

3. Establish self-scaffolding for learners: The self-scaffolding, learner integration, instructional resource discovery, individual learning, and abilities of evaluating self learning are constructed from teaching by scaffolding.

According to many instruction researches, scaffolding theories is indeed beneficial to learning effects for students. However, teaching by scaffolding are mostly applied to kindergarten level or special education in Taiwan. Up to now, few instructional applications of scaffolding have implemented in university programs, and an instructional model hasn't been designed by using scaffolding with Internet assistance. There are several significant achievements about teaching by scaffolding, which are integrated to instruction media design (Kao & Lehman, 1997 ; Oshima, Oshima & Ritsuko, 1999 ; Kao et al., 1996 ; Weston, Barker & Lecia, 2001). A teaching environment of CAI with scaffolding is used to teach statistic for college students and its teaching effects is proven that scaffolding is helpful and useful. Nevertheless, teaching methods developed by these studies are almost limited in the scope of experimental teaching. Still more, these methods would cost lots of time or efforts and there are only few methods can be effectively implemented in real teaching environment.

This paper would focus on developing a constructive scaffolding teaching model with Internet assistance

(CSTMIA) to actually apply to practical teaching and increase learning effects for students. This CSTMIA teaching model is practically applied to a master degree program of "Research Methods" in graduate school. By using CSTMIA, refining of teaching, adoptive of learning, and improvements of learning effects can be expected.

### 3. Instruction Design

"Research Methods" is an obligatory course in graduate schools, which is also an important tool to train research abilities of students. Therefore, this course depends on deeply comprehension, discussion, and interaction between teacher and students. In the past, many students often felt confused and can't have in hand after learning it. Characteristics of scaffolding teaching focus on mutual discussion and emphasizing teacher's assistance for students' learning, both are suitable for applying it to this course. For these reasons, an instructional model of CSTMIA is developed for this course, and moreover actually implemented in graduate school to find out its effects or influences on teaching in master degree level.

#### 3.1 Implementation Process

In this study, there are two groups of objects. One group has 23 students, and those are full-time graduate students. The other groups are 25 graduate students, and all of them are at work. A 10-weeks experimental instruction would be preceded in this course at autumn semester in 2001.

To avoid Hawthorne effect, students are not informed that they had been observing in the 10-weeks. All of the learning activities and assessments of students are included in grades counting. All sample in this study are departed into two groups resulted from different teaching methods. The experiment group is those 23 full-time graduate students. The control group is those 25 graduate students at work. These two groups have their own class and these two groups can't do inter-communication easily, that would ensure reliability of this experimental instruction. Students of the experiment group would receive CSTMIA approach in this course; the control group would receive TTM approach in this course. All of these objects are students major in department of MIS in NKFUST, so that all of them have basic abilities about using computers and Internet. Simultaneously, most of them have similar intelligence, similar learning situation, and similar background of domain knowledge. They have little inter-difference on the whole.

#### 3.2 CSTMIA System

The CSTMIA system is constructed for applying to

the course of Research Methods in this study. It has three main parts within this system.

1. Homepage functions: 6 items
  - a. Member login: Members can login the learning community, it has a mechanism of password accounting. If someone forgot password, system will e-mail it to him/her.
  - b. Professional's bulletin: Nonscheduled articles of professionals would be posted to share or discuss for learners.
  - c. Hot news: Latest academic information would be provided to learners.
  - d. Top 10: The top 10 warmly discussing articles would be announced.
  - e. Daily term: A scholarly term will be introduced for learners each day.
  - f. Advertisement blocks: Give advertisement chances for business.
2. On-line Learning: This is the key element in CSTMIA system and it has several functional items. Areas for achievements share, knowledge share, and discussion are three sections.
3. Q&A Services: Providing solutions and answers for learners to clear up common problems of using Internet.

### 3.3 Instruction Contents

Based on scaffolding theories and relevant literature reviews, three instruction levels are designed to increase learning effects in this study. CSTMIA is developed to facilitate teaching activities; its contents of the three levels are summarized in table 1.

1. The 2-phase instruction: There are two phases instruction of this course. In the first phase, teacher is the core element. This study adopts a pedagogical approach with TTM and web-based learning to be a temporary support, which would help learners develop their learning capabilities. The second phase aims at transferring learning responsibilities to learners. Learners would complete assignment of research proposal by their own knowledge that learned from the first phase.
2. Dialogue of instruction: In the first phase, the dialogue mainly exists between teachers and students. Teachers guide the instruction and makes brainstorming with students, and students can give opinion freely. In the second phase, the dialogue mainly exists among students. Students guide their collaborative learning, and each one should discuss with others.
3. Instruction activities: To promote students discussing and enhance learning abilities, these instruction activities are integrated with CSTMIA. At the beginning of instruction, students are requested to configure their learning responsibilities and learning target. And then, a temporary support with teaching in classroom and web-based teaching are provided to learners, which is a transfer of learning responsibilities from teacher to students. Finally, learners would establish their own self-scaffolding.
4. Instruction process: Constructive is the major principle, and students are principal part of learning. Knowledge would construct from active cognition of learners, rather than being instill it into learners by instructor. Teacher is just a mediator of knowledge, who merely guides students to construct their own knowledge structure.

Table 1: Contents of scaffolding teaching

Levels of Instruction \ Contents	CSTMIA
Instruction model	... 2-phase instruction and dialogue of instruction ... An instructional approach integrated TTM and web-based learning.
Instruction activities	... Configure learning responsibilities and abilities. ... Transfer of learning responsibilities ... Establish self-scaffolding for learner
Instruction process	... Constructive

### 3.4 Design of CSTMIA

Definition of scaffolding is that the growth of psychological capabilities of learner would rely on assistance of instructor or high-ability peers. This kind of assistance should ground on the learner's organization properties of cognition thereupon. Scaffolding can provide several supports for learning: 1. Provoked students' learning, 2. Figured out key characteristics of learning objects, 3. Provided relevant examples for students to inspect and learn, 4. Lightened learning loads, 5. Managed directions of learning activities, and 6. Controlled the discouragement in learning process (Wood, Bruner & Ross, 1976). Instructors supply a temporary support to assist student inspect and learn. This temporary support (the scaffolds) might be a kind of teaching facility or teaching strategy, as the capability of the learner advanced, the learning responsibility will shift gradually to the student, finally the student can dominate his/her learning, and through learning he/she shall build up his/her own knowledge (Rogoff & Gardner, 1984). According to these explanations, the instruction model in this study would aim at characteristics of the "Research Methods" to develop CSTMIA teaching approach.

Hence, the instruction design in this study would base on the viewpoints of scaffolding supports for learning (Wood, Bruner & Ross, 1976). Most of all, Internet assistance would proceed the design of scaffolding teaching in this study. There are three stages in the whole instruction progress, including configure learning responsibilities and target, proceeding of teaching activities, and analysis of learning results. Practical experiment of instruction is 10-week, which is implemented in the course of Research Methods on students in graduate school. Those research objects are graduate students in their first year major in MIS. Tasks of sequential stages of instruction is described as figure 2.

## 4. Research Methods

### 4.1 Research Model

This paper mainly focuses on discussing the effects of TTM and CSTMIA. Learning performance (subjective part of cognition and objective part of grades), learning satisfaction, interaction between teacher and student, and growth of learning abilities are factors concerned. Furthermore, still discussed whether CSTMIA strengthen more than TTM in aspects of learning performance, learning satisfaction, interaction between teacher and students, and the growth of learning capabilities. Resulting from these purposes and referring theory background, research model of this study is established as figure 3.

### 4.2 Variables

Several variables are determined according to the research model. Independent variables and dependent

variables are summarized in table 2, and each has specific description of operational definition.

#### 4.2.1 TTM: Traditional teaching means

that instructional activities are proceeding in campus or in classrooms. Teacher and students place themselves in the same space. Students have to obey some behavior rules and communication types due to environment conditions. Most teachers still play the roles of teller or disseminator. Learners always passively receive message (Dismuke, 1995).

4.2.2 CSTMIA: The basic concepts of scaffolding originated from the learning theories proposed by the Russian psychologist Vygotsky. Scaffolding states to let teachers provide a temporary support to help the students developing their self-scaffolding, this temporary support (the scaffolds) might be a kind of teaching facility or teaching strategy, as the capability of the learner advanced, the learning responsibility will shift gradually to the student, finally the student can dominate his/her learning, and through learning he/she shall build up his/her own knowledge (Vygotsky, 1962; Wood et al, 1976). In this study, Internet and the constructivist scaffolding teaching theories are applied to develop a teaching model to be applied to make up the teachers' deficiencies in terms of energy, time and capability.

#### 4.2.3 Learning performance:

Learning performance is an indicator that used to evaluate learners' study achievements, and it's also a main item to assess teaching qualities. Learning types, curriculum design, and instruction methods would influence learning performance. In this study, the evaluation of learning performance will be discussed in two parts. One part of evaluation is preceded with investigating the increase of learning performance when students writing down research proposal. It is also equal to evaluate their subjective cognition of learning performance. The other part of evaluation is to investigate total reputation of learning performance by their grades. Assignment grades, behavior of discussion, and representation in class are included in this part. Therefore, the grade is a kind of objective indicator for evaluating learning performance (Doran & Klein, 1996).

4.2.4 Learning satisfaction: Learning satisfaction can be a pleasure feeling, positive attitude, achievement of wishes or requiring, or awareness of abilities enhancing after students participated in learning activities. Learning satisfaction is a feeling or attitude toward learning activities, and it would resulted from students' preference of learning activities or achievement of wishes or requiring (Knowles, 1970; Ridley, Miller & Williams, 1995).

Table 2: List of research variables

Independent variables		Dependent variables
z	TTM	<ul style="list-style-type: none"> <li>• Learning performance (subjective part and objective part)</li> </ul>
z	CSTMIA	<ul style="list-style-type: none"> <li>• Learning satisfaction</li> <li>• Interaction between teacher and students</li> <li>• Growth of learning abilities</li> </ul>

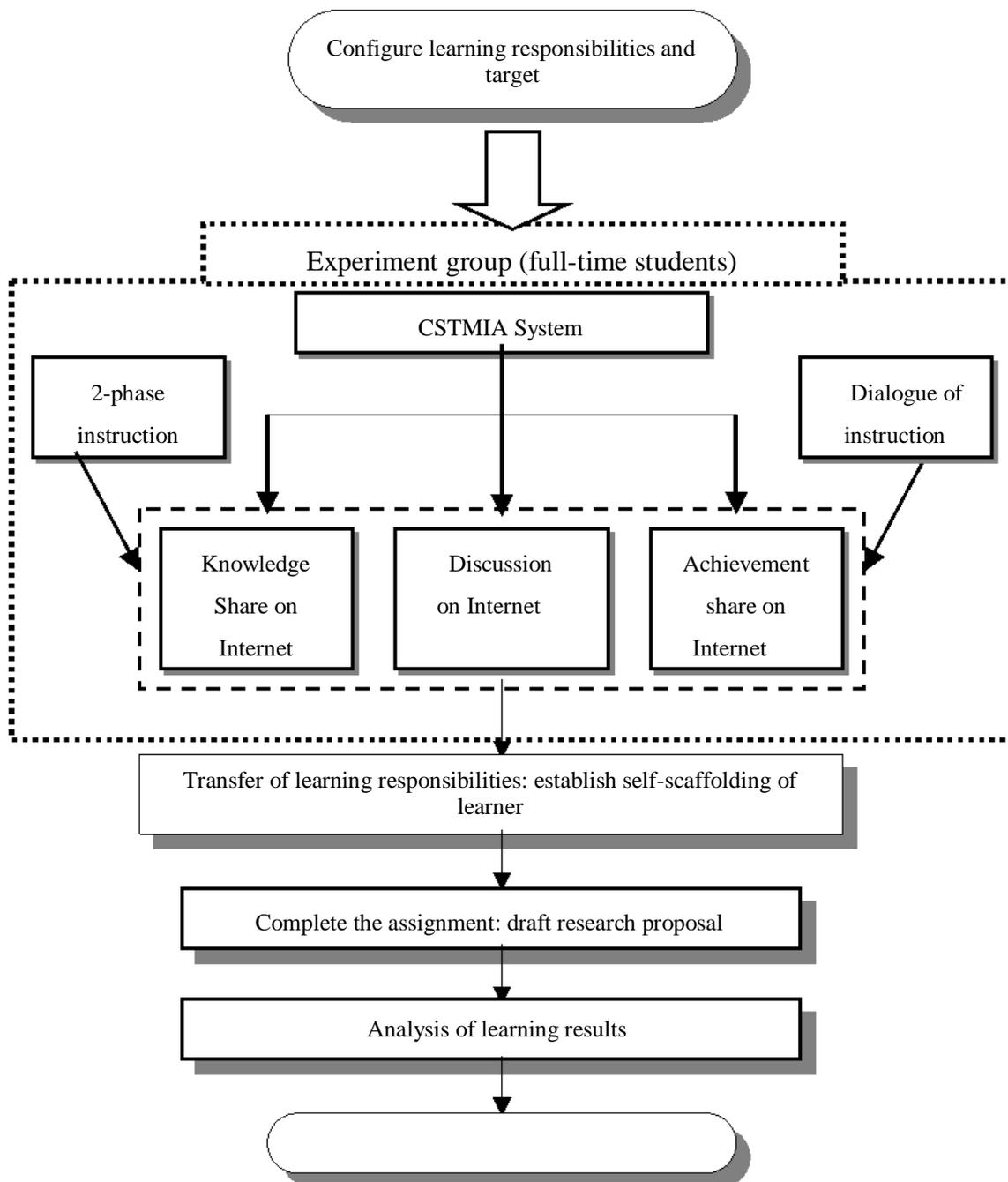


Figure 2: Tasks of sequential stages of instruction

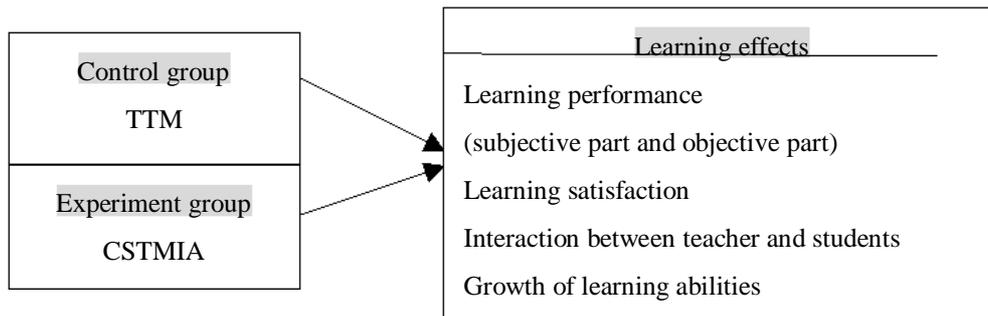


Figure 3: Research model in this study

#### 4.2.5 Interaction between teacher and students:

The process of communication between teacher and students to deliver words or non-verbal with E-mail or discussion areas at class or after class.

#### 4.2.6 Growth of learning abilities:

A set of behaviors or properties for determination, which indicate different level of learners in different attributes. The growth can be used to evaluate learning attitudes, strategy, interest, or the developing states of personality or affection.

There are several hypotheses made and induced from research purposes, reference, and research model in this study.

#### 4.2.7 The prediction of learning effects of CSTMIA and TTM:

Hypothesis 1:

CSTMIA cause better learning effects than TTM.

Hypothesis 1-1:

CSTMIA resulted of better grades of students than TTM.

Hypothesis 2:

CSTMIA cause better learning satisfaction than TTM.

Hypothesis 3:

CSTMIA cause better interaction between teacher and students than TTM.

Hypothesis 4:

CSTMIA cause more growth of learning abilities than TTM.

#### 4.2.8 If CSTMIA enhance more degree of interaction to learning effects than TTM:

Hypothesis 5:

CSTMIA enhance more degree of interaction to learning performance than TTM.

Hypothesis 5-1:

CSTMIA enhance more degree of interaction to learning grades than TTM.

Hypothesis 6:

CSTMIA enhance more degree of interaction to learning satisfaction than TTM.

Hypothesis 7:

CSTMIA enhance more degree of interaction to growth of learning abilities than TTM.

### 4.3 Questionnaires

There are two questionnaires designed to investigation in this study. One questionnaire is to investigate learning effects. This questionnaire refers to certain related questionnaire and it has validated by domain experts. The other questionnaire is to do subsequent evaluation and analysis. It is used to realize if CSTMIA can really enhance more degree of interaction to learning effects than TTM.

Both questionnaires have meet reliability requirement of Cronbach  $\alpha$  (all of them upper are than 0.7). The  $\alpha$  of four constructs of learning effects in the first questionnaire are larger than 0.7 (learning performance 0.9008, learning satisfaction 0.8530, interaction 0.8282, growth of learning abilities 0.7749). The  $\alpha$  of subsequent evaluation in the second questionnaire is 0.8348. Mention-above shows that questionnaires in this study are suitable and reliable.

### 4.4 Experiment design

To achieve the research purpose, experiment method is mainly adopted with static-group comparison in this study. Students in the experiment group adopt CSTMIA and the control group would adopt TTM instead. All of them have a 10-week learning schedule, and data collections in this period are served as empirical analysis. Differences between control group and experiment group are discussed, so do hypotheses validation.

### 4.5 Results

All data of questionnaire are collected and computed by One-way ANOVA method (under .05 significant level) to validate those hypotheses and confirm its effects. The statistic data are arranged in table 3.

Table 3: Statistic results of hypotheses

Hypotheses	p-value	Significance	Validation results
H 1	0.00373	***	Reject H 1
H 1-1	0.000	***	Non-reject H 1-1
H 2	0.000	***	Reject H2
H 3	0.0083	**	Reject H3
H 4	0.0049	***	Reject H4
H 5	0.000	***	Reject H5
H 5-1	0.000	***	Non-reject H 5-1
H 6	0.000	***	Reject H6
H 7	0.000	***	Reject H7

## 5. Discussion and Conclusion

### 5.1 The prediction of learning effects of CSTMIA and TTM:

Learning performance, learning satisfaction, interaction, and growth of learning abilities of CSTMIA have significant difference with TTM. The average grades of TTM are higher a bit than CSTMIA. The fact indicates that research results are just opposite to hypotheses. In order to realize this phenomenon, we've interview the teacher of this course and conclude some findings.

1. Students in the control group have stronger learning motives and positive learning attitudes.
2. Although students in the control learned with TTM, they performed better than comparing with the experiment group. Students in the control group always immediately ask questions they don't know in class.
3. Students in the control group have the courage to express their own opinion and viewpoints. They are able to warm discussions and issues without any guidance from teacher.
4. All students in the control group are at work and at least have 5 years experience of working. Their thinking abilities, representations, and achievement of learning target are indeed practiced well than students in the experiment group.
5. Students in the control group have more tricky attitudes on answering questionnaire because of their social experiences, therefore, more bias might be occurs than students in the experiment group as answering questionnaire. For this reason, the control group may have better effects. The subsequent evaluation and analysis can be deeply discussed the limitation to different learning groups in their learning motives.

In the part of learning grades, CSTMIA and TTM have significant difference in statistic analysis. The average grades of CSTMIA group have higher performance than TTM. We concluded several possible reasons of this result.

1. Students in the control group have more tricky attitudes on answering questionnaire

because of their social experiences, therefore, more bias might be occurs than students in the experiment group as answering questionnaire. For this reason, the control group may have better effects.

2. Learning grades is a total assessment, including daily performance, participation, assignment, etc. Most of all, the assignment of research proposal has largest proportion of grades, and teacher can grade students subjectively. Those would less cause bias than questionnaires.
3. Broadly, if eliminate the influences of objective factor and do subsequent evaluation to analyze results. CSTMIA would be still helpful to increase learning effects.

### 5.2 If CSTMIA enhance more degree of interaction to learning effects than TTM:

The level of interaction has positive correlation with learning performance, learning grades, learning satisfaction and growth of learning abilities. These results indicate that the more degree of interaction, the better learning effects would appear. If we can design certain mechanism that would stimulate students' participation, it would be a critical factor to increase learning effects. For example: apply a director of discussion area. The director would lead discussion, address issues, and make summary. If the director can lead members discuss some questions smoothly, learners will get used to this style of discussion. The discussion area will have its practical effects, and will enhance interaction between teacher and students to increase learning effects.

Although CSTMIA can merely increase learning grades as enhancing interaction to learning effects, learning performance, learning satisfaction, and growth of learning effects are not significant. After further investigation of this event, certain important clues can help to determine these appearances. The two samples of this study have great difference in learning motives, learning wills, learning enthusiasm, and participation. In other word, these two groups have inequality on their learning attitudes, and it will lead to worse results of experimental instruction. But it doesn't mean that CSTMIA is not good in this study, instead, most illnesses come from nature difference of samples.

There are some findings after the subsequent evaluation. Students in the experiment group adopt positive attitudes toward the CSTMIA approach. Therefore, CSTMIA is considered as beneficial tool and it would useful on increasing learning effects and enhancing interaction between teacher and students.

### 5.3 Impacts of teachers' loading as applying Internet to assist teaching:

After interviewing the teacher of this course, we concluded some findings.

1. It would shorten teacher lots of time and efforts on lecture by applying Internet to supports of examples, students can also easily learned key characteristics of learning objects.
2. The discussion area of CSTMIA system provides an on-line space to discuss, interact, and solve problems for teacher and students. They can communicate with each other and

lighten their learning loads of discussion as well. 3. Teacher can notice learning states of each student through discussion area. Teacher can also arrange instruction resource according to students' situation, which will decrease waste of efforts and shorten loads of time.

#### 5.4 Discussion and analyses of the subsequent evaluation:

The subsequent evaluation is quoted to comprehend students' subjective cognition about CSTMIA. We would like to know if CSTMIA could enhance more degree of interaction to increase learning effects after finishing the course of Research Methods. After analysis of the subsequent evaluation, more than 60% students in experiment group adopt positive attitudes toward effects of CSTMIA. They agree with the capability of such CSTMIA in the improvement of learning performance, learning achievement, learning satisfaction, interaction between teachers and the students, and the growth of learning abilities. This proves that the CSTMIA implemented by this study helps improve the learning effect, strengthen the interaction between teachers and the students in certain extent. The worse experiment results come from inequality on their learning attitudes of these two groups, and it will be influenced by man-made factors or subjective factors.

### 6. Contribution and Limitation

1. Establish a constructive scaffolding teaching model with Internet assistance on the course of Research Methods.

Scaffolding learning theories are usually discussed the learning effects in elementary and secondary school, or special education in Taiwan. Up to now, studies of learning effects are short of discussing scaffolding learning theories integrated information technologies for specific courses of university level or other higher education. Still more, these methods would cost lots of time or efforts and there are only few methods can be effectively implemented in real teaching environment. Hence, the first contribution of this study is to develop a CSTMIA pedagogical approach for actual practice to increase learning effects and being a basis for future reference by related courses.

2. Discuss the influence of CSTMIA to learning performance, learning grades, interaction, and growth of learning abilities.

Research Methods is an obligatory course in graduate schools, which is also an important tool to train research abilities of students. Therefore, this course depends on deeply comprehension, discussion, and interaction between teacher and students. In the past, many students often felt confused and can't have in hand after learning it. Characteristics of scaffolding teaching focus on mutual discussion and emphasizing teacher's

assistance for students' learning, both are suitable for applying it to this course. For these reasons, an instructional model of CSTMIA is developed for this course, and moreover actually implemented in graduate school to find out its effects or influences on teaching in master degree level.

3. Provide future reference for related studies

There are still few studies discussing about developing a scaffolding teaching model with Internet assistance in Taiwan. It is trusted that, results of this study can be a foundation of related studies and being a headstone for future complete model. For instance, sample selection ought to be more homogeneous in future days. The records of system logs about students' activities on web may be used to analysis. Adjust the proportion of grades on the part of participation and discussion to encourage students actively learning and discussion. Increase other assessment of performance evaluation in the initial stage and middle stage of semester, which will help to interpret learning curve in the process.

Undoubtedly, there are still some limitations in this study. On sample selection, it doesn't follow the principle of complete random sampling. Because the instruction experiment is practiced with unit of class, external validity may be influenced by the limitation of self-selection. That will make inference incomplete. Furthermore, the length of period of experiment time may influence learning effects too. Two conditions of time may be included for future discussion: Is a 10-week cycle of experiment appropriate? Is on-line time of using Internet resource will influence learning wills? Finally, bias of research data collection may be influenced by subjective factors of students. Those subjective factors can be personality or learning styles of students, or students' identification of teacher or this course. Most of these factors would influence research results.

### Reference

1. Alavi, M., B. C. Wheeler and J. S. Valacich, 1995, "Using IT to Reengineer Business Education: An Exploratory Investigation of Collaborative Telelearning," *MIS Quarterly*, Vol.19, pp.293-312.
2. Bickhard, M.H.,1997, "Constructivism and Relativisms : A shopper's guide," *Science & Education*, Vol.6, ppt.29-42.
3. Davis, D. L. and Davis, D. F., 1990 "The Effect of Training Techniques and Personal Characteristics on Training End Users of Information Systems," *Journal of Management Information System*, Vol.7, No.2, pp.93-110.
4. Dexter, S L., Anderson, R. E., & Becker, H.J.,1999, "Teachers' views of computers as catalysts for changes in their teaching practice," *Journal of Research on Computing in Education*, Vol.31, No.3, pp.221-239.

5. Dias, L.B., 1999, "Integrating technology : some things you should know," Learning & Leading with Technology, Vol.27, No.3, pp.10-13, 21.
6. Dismuke, C., 1995, Distance education [online], Available: <http://userwww.sfsu.edu/~Scarloyn/thesis.html>.
7. Doran, M. S., & Klein, J. D., 1996, "The effect of learning structures on student achievement and attitude using a computer simulation," (ERIC Document Reproduction Service No. ED 397 788)
8. Ertmer P.A., Addison, P., Lane, M., Ross, E., & Woods, D., 1999, "Examining teachers' beliefs about the role of technology in the elementary classroom," Journal of Research on Computing in Education, 32 (1), 54-72.
9. Kao, Michelle T.; Lehman, James D., 1997, "Scaffolding in a Computer-Based Constructivist Environment for Teaching Statistics to College Learners," Chicago, March 24-28.
10. Kao, Michelle T.; And Others, 1996, "Scaffolding in Hypermedia Assisted Instruction: An Example of Integration," 18th National Convention of the Association for Educational Communications and Technology, Indianapolis, IN.
11. Knowles, M. S., 1970, The modern practice of adult education. New York: Association.
12. Rogoff, B., & Gardner, W., 1984, Adult guidance of cognitive development. In B. Rogoff & J. Lave (Eds) , *Everyday cognition: Its development in social context* ( pp.95-116 ) . Cambridge, MA: Harvard University Press.
13. Ridley, D. R., Miller, B. G., & Williams, C. H., 1995, The 1995 assessment report on CNU online. (ERIC Document Reproduction Service No. ED 397070)
14. Slavin, R.E., 1990, "Synthesis of research on cooperative learning," Educational Leadership, Vol.48, No.2, pp.71-82.
15. Oshima, Jun; Oshima, Ritsuko, 1999, "Scaffolding for Progressive Discourse in CSILE: Case Study of University Undergraduate Programs," Montreal, Quebec, Canada, April 19-23.
16. Vygotsky, L.S., 1962, Thought and language. (E. Hanfmann & G. Vakar, Eds. And Trans.). Cambridge, MA: The MIT. Press (Original work published 1934)
17. Weston, Tim J.; Barker, Lecia, 2001, "Designing, Implementing, and Evaluating Web-based Learning Modules for University Students," Educational Technology, Vol.41, No.4, p15-22, Jul-Aug.
18. Woolfolk, A. E., 1993, Educational psychology, 5th ed., Allyn & Bacon., Boston.
19. Wood, D.; Bruner, J. S. & Ross, G, 1976, "The role of tutoring in problem-solving," Journal of Child Psychology and Psychiatry, Vol.17, pp.89-100.

# Combining Clustering and MCDM Approach for Evaluating Customer Lifetime Value Ratings

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## Abstract

Creating successful transaction actions to retain customers for future re-purchasing is extremely important in fiercely competitive environments. Moreover, different market strategies should be practiced for customers with different lifetime values and loyalty ratings. This work proposes a method, which combines clustering analysis and multiple criteria decision-making approach to evaluate customer lifetime value ratings, and construct the classification rules for individual clusters in market segmentation. An empirical case involving a hardware retailer is illustrated to show the usefulness for evaluating customer lifetime value ratings.

## 1. Introduction

A number of studies have discussed the evaluation of customer lifetime values (CLV) in terms of RFM (Recency, Frequency, and Monetary) [3][4][5][6][7][14][15][11]. Goodman [3] suggested that RFM method would avoid focusing on less profitable and instead allow these resources to be diverted to more profitable ones. From the behavioral perspective, the RFM measuring method is an important method for assessing the relationship between enterprise and customers.

Hughes [5] proposed a method for RFM scoring, which involves sorting the real data of RFM individual into 5 customer quintiles. Meanwhile, Stone [15] hypothesized that different weights should be assigned to RFM variables according to industry characteristics. To analyze the value of customers who paid using credit cards, Stone suggested placing the highest weighting on the number of purchases, followed by the period of purchase time, while placing the lowest weighting on the amount of purchases. Although various combinations and weightings have been proposed, judging and weighting RFM variables remains subjective.

This study uses an analytic hierarchy process (AHP) [12][13] to evaluate the importance (weight) of each RFM variable by the perception of decision makers. The K-means clustering is used to group customers into those with similar lifetime values or loyalty based on the performance value of RFM. Each target market can be further ranked using multiple criteria decision making (MCDM) approach. Finally, classification rules are determined for each cluster using the decision tree

algorithm C5.0. The classification rules are employed to predict other potential customers regarding their groups and loyalty ranking. The case of hardware retailer is used for the sake of illustration.

The remainder of this study is organized as follows. Section 2 reviews related work in evaluating CLV. Section 3 then outlines the methodology used herein. Next, Section 4 presents a case study for evaluation. Section 5 construct rulesets for target market using a decision tree approach. Finally, the conclusion summarizes the contributions of this study and outlines areas for further research.

## 2. Related work

### 2.1. Market segmentation

Chen et al. [2] noted that clustering is one of the data mining tools used to discover knowledge processes. Clustering aims to maximize variance among groups while minimizing variance within groups. In clustering, many algorithms have been developed, such as k-means, hierarchical, fuzzy c-means approaches and so on.

This study applies K-means method to cluster customers based on their CLVs. The K-means method involves iterative improvement that can compensate for a poor initial partition of data. The number of clusters must be predetermined with the K-means method.

### 2.2. Evaluation of CLV

Bult et al. [1] explain the RFM terms as follows: (1) R (recency): time period since the last purchase, and the lower the value is, the higher the probability of the customer making a repeat purchase; (2) F (frequency): number of purchases made within certain time period; higher frequency indicates higher loyalty; (3) M (monetary): the amount of money spent during a certain time period; increasing monetary contribution from customers indicates increased focus on the company supplying the products.

Hughes [5] developed a widely used method for evaluating RFM. Each RFM is divided into 5 quintiles. With the ordering of customers from the top to the bottom, in the increasing order of recency values, the R scores of top 20% customers are set to 1, while those of the bottom 20% customers are set to 5. The F scores and M scores are assigned similarly, using the decreasing order of

frequency and monetary values, respectively. Accordingly, the RFM score of the best customer equals 111, while that of the worst equals 555. Different marketing strategies can thus be developed for different customers. Stone [15] hypothesized that the weights of RFM variables vary depending on industry characteristics. To analyze the value of customers with credit cards, Stone proposed that the frequency should be assigned the highest weighting, followed the recency, and finally, the monetary.

In practical applications, RFM variables need to measure different weights in different industries (e.g., [15]). However, Stone [15] determined the RFM weightings subjectively, without using a systematic approach or evaluation to determine the RFM weightings. This study employs AHP to evaluate each weight (relative importance) among RFM variables, and specifically asks decision makers to make intuitive judgments about ranking order to produce pairwise comparisons.

### 2.3. Decision tree

The earliest decision tree algorithm was extended from Concept Learning System (CLS) – Iterative Dichomizer 3 (ID3), which works by computing a metric known as the information gain ratio [8]. The spirit of decision tree is achieved by maximizing the information gain threshold at each node in the decision tree and the way to evaluate is based on classification validation. The ID3 has been refined into C4.5 by [9]. This study uses the latest C5.0 algorithm proposed in 1998, and the See5 software released by the company Rulequest [10].

## 3. Methodology for evaluating CLV ratings

This study proposes a method that combines clustering analysis and MCDM approach to evaluate the customer lifetime values or loyalty based on weighted RFM. Figure 1 shows the proposed methodology.

(1) Prepare a marketing database from enterprise; and remove nonsensical records such as those of customers who have purchase amount but never create any transactions. Next, the characteristics and purchase behavior of consumers are generated using simple statistics.

(2) Extract RFM variables for each customer to evaluate their lifetime values.

(3) Segment the market according to customer lifetime values by K-means; use the analysis of variance (ANOVA) to test whether RFM significantly discriminates against these market segments; and rank each market by MCDM with two models for comparison: one, without any preference, meaning equal weights among RFM, and the other with preferences, i.e., weight assessment is based on the AHP [12][13].

(4) Construct the classification rules for each market segmentation, and predict another potential customers by See5/C5.0.

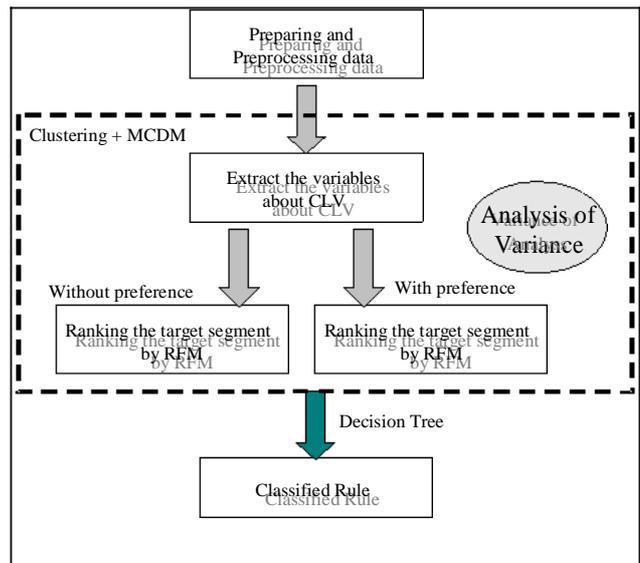


Fig. 1. Methodology for evaluating CLV ratings

## 4. Empirical study

An empirical case is used to show the usefulness of our approach for evaluating CLV ratings.

### 4.1 Preprocessing the data set

The empirical study is conducted using a data set collected from a company that manufactures wheels, casters, platform and hand trucks for industry, medical, hospital equipment and institutional purpose. The data set comprises 7,500 customers and 70,000 purchases records. These data were gathered from 2000/1 to 2002/4. Four related tables of transactions (Product, Transaction, Customer and Customer\_classify) were extracted. After removing unreasonable records, the remaining contains 60,000 records.

Specifically, in the table Customer\_classify, there are 3 types of customers, retailers, assembly industry and end users. Since the purchase records of retailers cover over 50% of all purchase records, this study analyzes the purchase records of retailers, which contains 984 customers.

### 4.2 Extracting the RFM values

Table 1 shows the RFM values for each 984 customers in hardware retailers, which are extracted from the dataset to measure CLV.

Table 1. RFM values for each customer

Customer no.	R	F	M
1108001	65	434	1252430
1108003	411	7	37930
...	...	...	...
1860003	159	87	313763

### 4.3 Evaluating CLV ratings with RFM clustering

#### 4.3.1 Identifying target groups

The K-means method is used to group customers with similar lifetime value or loyalty. Eight possible combinations of inputs pattern (RFM) are made from  $2 \times 2 \times 2$ . Table 2 shows the result. The average RFM variable values for each cluster are then compared with the total average RFM values of all clusters (163.57, 40.38 and 159481.1). If the average exceeds the total average, an upward arrow  $\uparrow$  is given, while if the opposite occurs, a downward arrow  $\downarrow$  is given.

Table 2. The result of K-means clustering

Cluster no.	Total Customers	Pattern
1	19	R $\uparrow$ F $\uparrow$ M $\uparrow$
2	136	R $\uparrow$ F $\downarrow$ M $\downarrow$
3	54	R $\uparrow$ F $\downarrow$ M $\downarrow$
4	30	R $\downarrow$ F $\uparrow$ M $\uparrow$
5	136	R $\downarrow$ F $\uparrow$ M $\uparrow$
6	467	R $\downarrow$ F $\downarrow$ M $\downarrow$
7	94	R $\uparrow$ F $\downarrow$ M $\downarrow$
8	48	R $\uparrow$ F $\downarrow$ M $\downarrow$

Analysis of variance is conducted to test whether RFM variables could discriminate 8 clusters. The analysis result would reject  $H_0$ , because the p-values are significant ( $p < 0.05$ ). Thus, the result confirms that 8 clusters would be discriminated based on recency, frequency and monetary significantly.

Customers in cluster 4 and 5 have the same characteristics, both their average recency are less than the total average; frequency and monetary are greater than the total average (R $\downarrow$ F $\uparrow$ M $\uparrow$ ). Consequently, the customers in cluster 4 and 5 can be considered to be loyal customers who frequently visit and make large purchase.

Cluster 2, 3, 7 and 8 show the pattern of R $\uparrow$ F $\downarrow$ M $\downarrow$ , and are likely to be the clusters with customers of least loyalty. Such customers almost never visit and make transactions. Furthermore, they generally only make purchases during sales. Enterprises can reduce prices to attract these customers, but in so doing will suffer reduced margins. Cluster 6 displays the pattern of R $\downarrow$ F $\downarrow$ M $\downarrow$  and may represent new customers who have recently visited the company to make purchase.

Finally, Cluster 1 displays the pattern of R $\uparrow$ F $\uparrow$ M $\uparrow$ , and represents customers who may once have enjoyed a good relationship with the company, and have higher than average purchase frequency and purchase amount. However, customers in this cluster have not made transactions recently, possibly because of moving their businesses or bankruptcy.

#### 4.3.2 Rating without preference on RFM

This section evaluates the rating on market segmentations, without preference on RFM variables, i.e.,

the RFM criteria have equal weight. Let  $w = [w_R, w_F, w_M]$ , where  $w_R, w_F, w_M$  represent the weight (relative importance) on RFM, respectively. The MCDM approach to evaluate the customer lifetime value ratings is illustrated as follows.

##### (1) Determining the RFM weightings

Herein,  $w_R = w_F = w_M$ .

##### (2) Constructing the normalized performance matrix

The normalized performance matrix  $D$  contains 8 clusters associated with the RFM criteria. The 8 clusters are generated using K-means method based on RFM, as illustrated in Section 4.3.1. Let  $x_{ij}$  be the performance value of the  $i$ th cluster with respect to the  $j$ th RFM criteria in  $D$ .  $x_{ij}$  can be derived via computing the average R, F, and M value for each cluster  $j$ . Moreover, the normalized performance value ( $r_{ij}$ ) of each cluster is derived as follows: the profit form,  $r_{ij} = (x_{ij} - x_j^-) / (x_j^* - x_j^-)$  is used to normalize the frequency and monetary values, since they positively influence CLV or loyalty. The cost form,  $r_{ij} = (x_j^* - x_{ij}) / (x_j^* - x_j^-)$  is used for recency, since it has negative impact on CLV. Notably,  $x_j^*$  is the best performance value of all in  $j$ th criterion;  $x_j^-$  is the worst.

##### (3) Ranking the performance order

The weighted normalized performance value,  $v = [v_1, v_2, \dots, v_8]^T$ , can be derived by multiplying the normalized performance matrix  $D$  and the  $w^T$ , i.e.,  $v = [D \times w^T]$ . The rankings of each market segmentation (cluster) can be determined according to the weighted normalized performance values of clusters, as shown in the right most column of Table 3. For example, the loyalty ranking of market segmentation 4 (cluster 4) equals 1.

Table 3. The rating of clusters without preference on RFM ( $w_R, w_F$ , and  $w_M$  are equal)

Cluster no.	R	F	M	Weighted Performance Value (v)	Loyalty Ranking
1	0.71	0.39	0.47	1.58	3
2	0.81	0.06	0.04	0.91	5
3	0.61	0.02	0.02	0.65	6
4	1.00	1.00	1.00	3.00	1
5	0.99	0.39	0.30	1.69	2
6	0.98	0.09	0.07	1.13	4
7	0.37	0.07	0.07	0.50	7
8	0.00	0.00	0.00	0.00	8
Average	0.68	0.25	0.25		

The fourth cluster displays the highest loyalty (Table 3), followed by the fifth cluster. That appears especially clear for decision makers to know which market segmentation is the main target of a company. Table 3 indicates that cluster 2, 3, 7 and 8 are the disloyal groups of customers, with group 8 being the worst, and thus the

company should pay less attention to these groups and distribute less resource to them.

### 4.3.3 Rating with preference on RFM

This section conducts experiment to determine the ranking of CLV or loyalty for market segmentations (clusters) based on weighted RFM. AHP [12][13] is first used to assess the weightings (preferences) among RFM variables.

Three groups of evaluators exist: (a) 3 administrative department (managers); (b) 2 sales division (business manager, sales) and 1 marketing consultant; and (c) 5 customers who have made purchases. The above groups were invited to evaluate the criteria weightings. Data were gathered by interviewing evaluators, and an interview was conducted via a questionnaire (see Appendix, Table 5), with the answers being expressed in the form of a pairwise comparison matrix (see Appendix, Table 6).

#### (1) Determining the RFM weightings

According to the analytical result of AHP,  $w_R$ ,  $w_F$ , and  $w_M$  are 0.7306, 0.1884 and 0.081, respectively.  $w_R$  has the highest ranking, followed by  $w_F$  and  $w_M$ . The implication of this ranking on the preference of RFM is as follows. Recency is the most important, since the unit price of hardware products is relatively low, and thus evaluators only care about whether customers purchase continuously or not. In addition, customers, without any transaction activities in long periods, could have been lost or have transferred to new vendors.

#### (2) Constructing the normalized performance matrix

This step of constructing the normalized performance matrix D is the same as the step (2) in Section 4.3.2.

#### (3) Ranking the performance order

This step of ranking the performance order is similar to the step (3) in Section 4.3.2, except that  $w_R$ ,  $w_F$ , and  $w_M$  are different, as derived from step (1). Table 4 shows the result of the rating on market segmentations, according to the preferences on RFM variables.

The ranking between cluster 1 and 6 in Table 4 differs from that in Table 3. That seems reasonable. For cluster 1 in Table 4, the frequency (0.39) and monetary (0.47) are higher than the total average F (0.25) and M (0.25). However, the time period since last purchase (recency) is very long, indicating that the customers in this cluster may have been lost or have transferred to other vendors.

For the cluster 6 in Table 4, although the frequency (0.09) and monetary (0.07) were lower than the total average, the recency (0.98) indicates that they have recently been active. Marketers should devote greater effort to retaining customers in cluster 6 than those in cluster 1. However, if individual RFM weightings are not considered, as the result shown in Table 3, cluster 1 ranks ahead of cluster 6. The comparison implies that the proposed approach may be a better method for evaluating

the ranking of CLV, and the result is consistent with decision makers.

Table 4. The rating of clusters with preference on RFM ( $w_R$ ,  $w_F$ , and  $w_M$  are different)

Cluster no.	R	F	M	Weighted Performance Value (v)	Loyalty Ranking
1	0.71	0.39	0.47	0.63	4
2	0.81	0.06	0.04	0.61	5
3	0.61	0.02	0.02	0.45	6
4	1.00	1.00	1.00	1.00	1
5	0.99	0.39	0.30	0.82	2
6	0.98	0.09	0.07	0.74	3
7	0.37	0.07	0.07	0.29	7
8	0.00	0.00	0.00	0.00	8
Average	0.68	0.25	0.25		

### 4.4 Classifying the target groups

See 5 software [10] based on C5.0 algorithm is used to construct decision tree and classification rules for each cluster. These classification rules are used to predict other potential customers belonging to which target market and mapping to which loyalty ranking. This approach can help decision makers to consider relevant marketing strategies. The samples are randomly divided into calibration (70%) and validation (30%) of total customers (984). The calibration samples are used as a training set to construct the classification rules, and then validation cases are classified for testing. The accuracy rate is critical to validating the classification result.

Each rule summarized the performance using the statistics (N/E, lift L) or (N, lift L) where: (1) N denotes the number of training cases covered by the rule; (2) E (if shown) represents the number of training cases covered that do not belong to the rule's class. Meanwhile, the accuracy of the rule is estimated by the Laplace ratio  $(N-E+1)/(N+2)$ ; (3) L is the estimated rule accuracy divided by the previous probability of the rule class. Taking rule 9 as an example, if Recency  $\leq 117$  and Frequency  $\leq 63$ , then cluster 6 contains 325 customers. The accuracy of the rule is estimated to equal 0.997.

Rule 9: (325, lift 2.1)

Recency  $\leq 117$  Frequency  $\leq 63$  class 6 [0.997]

Finally, the classification result of the calibration and validation samples is evaluated. 11 rule sets are produced to classify 8 different clusters. The result shows 3.4% error rate of classification for validation samples.

### 5. Conclusions

In this paper, an analytical approach, combining clustering analysis and MCDM approach, is proposed to evaluate CLV ratings. The analytical result demonstrates that our approach would define the target market more

clearly via AHP weighting and performance ranking than without weighting on RFM. The result helps market practitioners to make more effective strategies for retaining customers.

Moreover, to target potential customers, this study uses the classification approach to predict other potential customers for future purchases. Decision tree algorithm – C5.0 is used to classify these clusters (market segmentations) generated by K-means clustering. Classification rules based on RFM variables are extracted to classify 8 clusters. The result shows 3.4% error rate of classification for calibration samples.

There are two limitations of our study. First, we experimentally evaluate our approach on the data set collected from hardware retailers. Although customer purchase behavior are often available in marketing database, customer privacy and security concerns cause difficulty in obtaining more databases to verify whether our approach would be appropriate to other application domains, such as supermarkets or electronic commerce. Second, we assume that the relationship among RFM variables is linear. In fact, the purchase frequency always affects purchase amounts, and thus further research is required to relax the linear assumption.

## Appendix

Table 5. AHP questionnaire sheet for RFM

Importance degree										
Criteria	9	7	5	3	1	3	5	7	9	Criteria
Recency	9	7	5	3	1	3	5	7	9	Frequency
Recency	9	7	5	3	1	3	5	7	9	Monetary
Frequency	9	7	5	3	1	3	5	7	9	Monetary

Table 6. Retailer’s RFM pairwise comparisons matrix

	Recency	Frequency	Monetary
Recency	1	5	7
Frequency	1/5	1	3
Monetary	1/7	1/3	1

## References

- [1] Bult, J.R., and Wansbeek, T.J. (1995), Optimal selection for direct mail, *Marketing Science*, 14 (4), pp. 378–394.
- [2] Chen, M.S., Han, J., and Yu, P.S. (1996), Data mining: an overview from a database perspective, *IEEE Transactions on Knowledge and Data Engineering*, 8(6), pp. 866-883.
- [3] Goodman, J. (1992), Leveraging the customer database to your competitive advantage, *Direct Marketing*, December, pp. 26-27.
- [4] Ha, S.H., and Park, S.C. (1998), Application of data mining tools to hotel data mart on the Intranet for database marketing, *Expert Systems with Applications*, 15(1), pp.1-31.
- [5] Hughes, Arthur M. (1994), *Strategic Database Marketing*, Chicago, Probus publishing.
- [6] Kahan, R. (1998), *Using database marketing techniques to enhance your one-to-one marketing initiatives*, *Journal of Consumer Marketing*, 15(5), pp. 491-493.
- [7] Miglautsch, J. (2000), Thoughts on RFM scoring, *Journal of Database Marketing*, 8(1), pp. 67-72.
- [8] Quinlan, J.R. (1979), Discovering rules by induction from large collections of examples. In *Expert Systems in the micro-electronic age*, D. Michie (ed.), pp. 168-201. Edinburgh: Edinburgh University Press.
- [9] Quinlan, J.R. (1993), *C4.5: programs for machine learning*, Morgan Kaufmann Publishers.
- [10] Rulequest research, (1998), *Data mining tools See5 and C5.0*, <http://www.rulequest.com/See5-infor.html>.
- [11] Saarevirta, G. (1998), Data mining to improve profitability, *CMA Magazine*, March, pp. 8-12.
- [12] Saaty, T.L. (1980), *The analytic hierarchy process*, McGraw-Hill, New York.
- [13] Saaty, T.L., Vargas, L.G. (1982), *The logic of priorities: application in business, energy, health, and transportation*. Kluwer-Nijhoff, Boston.
- [14] Shaw, M.J., Subramaniam, C., Gek Woo Tan and Welge, M.E. (2001), *Knowledge Management and Data Mining for Marketing*, *Decision Support Systems*, 31(1), pp. 127-137.
- [15] Stone, Bob (1995), *Successful direct marketing methods*, Lincolnwood, IL: NTC Business Books.

# Applications of Knowledge-Enabled CRM

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## Abstract

Knowledge Management (KM) is the process of managing organizational knowledge from creating business value that will focus on creating and delivering innovative products or services and managing relationships with existing key stakeholders in the context of Customer Relationship Management (CRM). The value of KM and CRM is well recognized by many leading companies. Application of Knowledge-enabled Customer Relationship Management (KCRM) is a great opportunity to increase the customer value and provides a way to systematically attract, acquire and retain the customers. This study has taken a beauty enterprise as an example and focused on its franchise stores to perform a field study. A strategic knowledge-enabled CRM framework is introduced in order to classify the subjects by customer-oriented perspective. From the responses of the surveyed beauty enterprise, it is demonstrated how the companies can develop their customer connection strategies based on their current and future positions in four dimensions of the value compass model. Moreover, this study presented a conceptual model of KCRM to see how KM can help CRM implementation.

Keywords: Knowledge Management, Customer Relationship Management, e-Business

## 1. Introduction

Electronic Commerce (EC) has changed the traditional focus of Information Technology (IT) and created a fast-changing business environment. Within such a competitive environment, long-term relationship with customers is one of the most important assets in the companies, which can increase their competitive advantages and improve their profitability substantially. E-businesses focus on their marketing efforts on building lasting relationship with customers through CRM and better understand what customer wants and needs becomes obvious [6]. Conducting business through electronic commerce, the handling of transactions over communications networks, continues to grow in a seemingly unabated fashion. Recently, several leading companies have taken advantage of the CRM power to expand their markets sharply [7]. These companies

establish CRM systems to maintain and further create loyal customers. Unfortunately, most of the companies have limited knowledge about CRM and ignore its importance. It is a common sense that the loss of good opportunity to better serve customers may create great opportunity for the competitors to increase their market share. In response to increasingly competitive environments, companies examine how they can better leverage knowledge assets and create added value. Davenport and Prusak [4] have emphasized that KM addresses the issues of creating, capturing, and transferring knowledge-based resources. Taking the beauty industry as an example, the improvement of the customer relationship for a company in the beauty industry can therefore generate great business opportunity. This study has taken the beauty industry as an example to perform a comparative study between Taiwan and China. A strategic KCRM framework is introduced in order to classify the subjects by customer-oriented perspective. In specific, this paper studies four interrelated objectives in order to get a holistic view of customers and their relationship to the entire enterprise as follows.

1. Provide a framework of KCRM.
2. Conduct a comparative study of KCRM between Taiwan and China franchise stores.
3. Discuss opportunities for Taiwan and China beauty Industry to leverage customer knowledge and to create value for customers based on the findings.
4. Help Taiwan and China beauty industry understand the needs of each other and further find the possibility to develop the new market.
5. See how KM can help CRM implementation.

## 2. Literature review of CRM and KM

Tiwana [11] defined Knowledge-enabled Customer Relationship Management (KCRM) as "Managing customer knowledge to generate value-creating lock-ins and channel knowledge to strengthen relationships and collaborative effectiveness, Knowledge-enabled CRM is more of a business model/strategy than a technology-focused solution." He clearly identified knowledge management and customer relationship management for every business decision-maker and IT professional. The availability of large volume of data on

customers, made possible by new technology tools, has created opportunities as well as challenges for businesses to leverage the data and gain competitive advantage. Shaw et al. [10] have presented a systematic methodology that uses data mining and knowledge management techniques to manage the marketing knowledge and support marketing decisions. Lesser et al. [3] have identified four approaches (customer knowledge development dialogues, facilitating the capture of knowledge relevant data, demonstrating enterprise leadership commitment to customer knowledge) that can expand the availability and use of customer knowledge. Lin [5] presents a systemic integrated communications model that may help enterprises identify the potential issues of CRM. Wayland and Cole [12] have presented the Value Compass model which makes explicit connection between what managers know about their customers and how they can leverage that information to create customer value. Arthur Andersen Business Consulting [1] identified that customer knowledge base is one of the ten high performance of KM. So CRM together with Knowledge Management (KM) could be further studied.

As shown from these researches, directly related to and underlying CRM is the emerging discipline of KM. Although a surge in emphasis and interest on both CRM and KM such as popular press reports, books, conferences, the growing number of CRM and KM systems, vendors, consultants and so on. Massey et al. [9] have explored the leading company IBM's first effort to re-engineering the CRM process by leveraging technology and its knowledge-based resources. Moreover, enabling CRM through KM inside IBM represented a full-fledged business approach to the acquisition, assembly, and application of knowledge to the CRM process.

### 3. Research Model

#### 3.1 Problem background

The beauty enterprise in this study has the most franchise stores in Taiwan and most expert Taiwan-based multinational beauty conglomerate. It manufactures a great variety of products in Taiwan and has markets the superb quality products into the world markets in its own brand for a long time. It has further expanded its service for worldwide counterparts in the UK, France, Italy, Germany, the United States, Uruguay and Argentina. In the integral global structure under the brilliant leadership, this beauty enterprise constantly insists on corporate philosophy of research, education, services and promotion; combining research, production, training, marketing, promotion and service into a whole. Unlike conventional marketing of franchises, it features diverse, international, systematic and standard management to assure integration in education, technologies theories, products, equipment, systems, trademarks, ads, marketing and management and, furthermore, develop the world-admired marketing networks. This beauty

enterprise now has around 600 franchise stores in Taiwan and 2000 franchise stores in China. Knowing their customers better is very important especially through KCRM.

In our conceptual model, we will consider strategic analysis of CRM and further see how KM can help the process of CRM implementation successfully. The conceptual model is displayed in Figure 1.

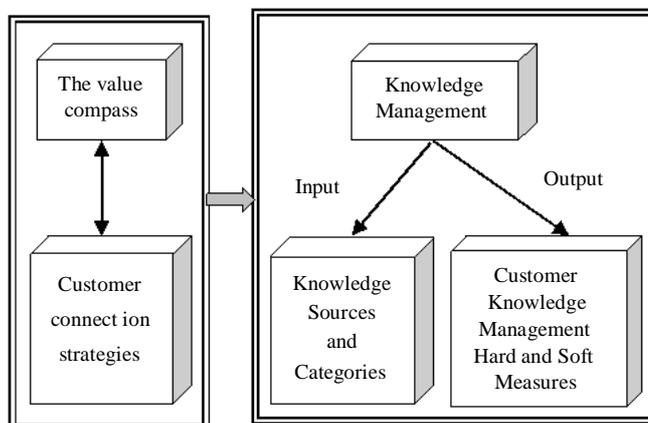


Figure 1 The conceptual model

#### 3.2 Strategic analysis of KCRM

Based on our previous studies [6] [7] [8], Wayland and Cole's [12] value compass model will help to do strategic analysis of CRM. Customer knowledge, customer-connecting technology, and customer economics are the foundations of customer-connected strategy. They make it possible to determine where a business can position itself along each of the four dimensions of the value compass model.

The four dimensions of the value compass model provide ways for business to identify and manage customer relationships, to measure business's contribution to its customer value chain, to decide the position of the company within the industry value-added chain, and to decide, on this basis, which customers and suppliers can create and share better value. A comparative study of KCRM between Taiwan and China franchise stores can evaluate where they are on the value compass model at present and in the future and furthermore get ideas about KCRM strategies.

#### 3.3 How KM can help the process of CRM implementation

Beckman [2] identified 8 steps of KM: knowledge identify, knowledge capture, knowledge select, knowledge store, knowledge share, knowledge apply, knowledge create and knowledge sell. This study took advice from 5 senior managers of the beauty enterprise and select 5 steps: knowledge select, knowledge capture, knowledge share, knowledge create and knowledge store.

Tiwana [11] provided knowledge source and categories such as markets, competitions, customers, orders, contracts, products and services, problems and best practices. Basically, knowledge about these sources and categories must be integrated into a knowledge-enabled CRM strategy. In general, that what can be measured is not always important, and what is important cannot always be measured. The example of hard and soft measures from Tiwana [11] can serve the indicators of the business impact of customer knowledge management (As shown in Table 1). Our concept is to identify how important the knowledge sources and categories and customer knowledge management hard and soft measures are. Moreover, how KM is so important and can further help the process of CRM implementation.

Table 1 Hard and soft measures [11]

Hard	Soft
Cost savings	Customer satisfaction
Customer retention	Customer loyalty
Repeat purchases	Customer and employee productivity
Market share	Employee loyalty
Customer acquisition rate	Employee empowerment
Cost of sales/expense reduction	Defection likelihood
Stock valuation	Market leadership
Bottom-line effects	Organizational stability
Profit margins	Cultural change

### 3.4 Hypothesis development

The hypothesis development is identified as follows and will be explained later.

- H<sub>1</sub>: There is significant different between current and future position of the value compass model in Taiwan.
- H<sub>2</sub>: There is significant different between current and future position of the value compass model in China.
- H<sub>3</sub>: There is significant difference between Taiwan and China in the KM dimension.
- H<sub>4</sub>: There is significant difference between Taiwan and China in the customer resources and categories dimension.
- H<sub>5</sub>: There is significant difference between Taiwan and China in customer knowledge management hard and soft measures dimension.

## 4. Research method and design

This study proceeded in three phases. First, a qualitative approach that included a literature review was

employed. The purpose of this phase was to get basic knowledge about the topic. Secondly, a quantitative approach that included the development of a questionnaire was conducted. Lastly, the deep case study was conducted to validate the research findings, to assist in the interpretation of the results and to see how KM can help CRM implementation. We aimed to ascertain:

- (1) Where are the current and future marketing strategies for the franchise stores of the beauty enterprise in Taiwan and China on the value compass model ?
- (2) How do these franchise stores consider about their customer connection strategies ?
- (3) How KM can help CRM implementation successfully for the beauty enterprise ?

Phase three of this research involved a further case study stage. The purpose of this phase was to discuss the research findings with interviewees of the beauty enterprise in order to explain and validate the findings of the questionnaire.

## 5. Research findings

This field study focused on the selected beauty enterprise and the questionnaires were sent to 35 franchise stores in Taiwan and 70 franchise stores in China. The questionnaires were sent by its headquarter and all returned. There were 30 available responses from 35 franchise stores in Taiwan and 66 available responses from 70 franchise stores in China. An analysis of scale reliability was performed using Cronbach's alpha coefficient. The final scale reliabilities were 69.18% for knowledge management (5 items), 79.69% for knowledge sources and categories (8 items), and 84.68% for customer knowledge management hard and soft measures (2 item).

### 5.1 Strategic analysis of KCRM

The strategic analysis of KCRM will be separated into two parts.

- (1) The value compass

The current and future position for the subject on the value compass in Taiwan and China are shown below in Table 2. As shown below in Figure 2, the franchise stores in Taiwan current stay on market, extended offer, product manager and neutral and will more to market, extended offer, network manager and outcome levels. In the Figure 3, the franchise stores in China current stay on market, extended offer, process manager and performance levels and will stay on market, extended offer, network manager and outcome levels in the future. Clearly, although there is difference between Taiwan and China currently, they have the same future view on the value compass model. According to H<sub>1</sub> and H<sub>2</sub> as mentioned before, Table 3 indicates the results as follows. It seems that there is no significant

difference between current and future position in all dimensions of the value compass model in Taiwan. However, there is significant difference between current and future position in value proposition design, value-added role, and reward and risk sharing dimensions of the value compass model in China. Not surprising, China economics is growing like flying. The people in China expect a lot of progress in the future. So these three dimensions have to be urgently considered to change.

Table 2 The current and future positions on the value compass in Taiwan and China

Dimension		Taiwan		China	
		Current	Future	Current	Future
Customer portfolio management	Market	17	21	41	42
	Group	7	8	21	20
	Individual	6	1	4	4
Value proposition design	Core product	4	2	14	20
	Extend offer	13	15	37	29
	Total solution	13	13	15	17
Value-added role	Product manager	18	9	23	20
	Process manager	7	9	30	19
	Network manager	5	12	13	27
Reward and risk sharing	Neutral	15	10	20	20
	Performance	10	9	31	20
	Outcome	5	11	15	26

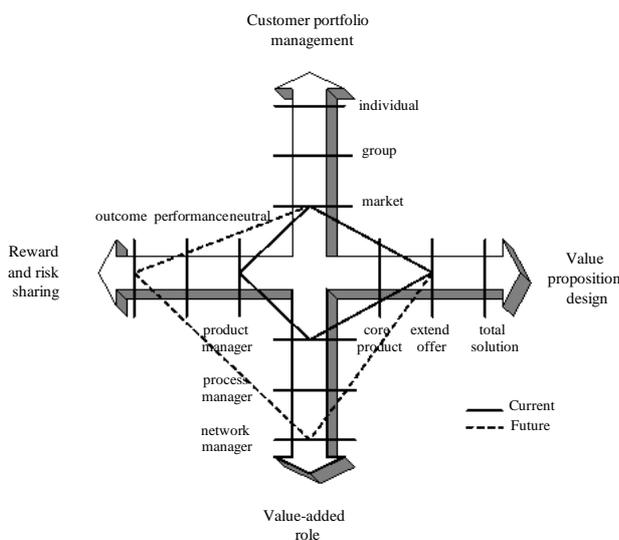


Figure 2 The value compass in Taiwan

Table 3 The significant difference between current and future position in Taiwan and China on the value compass model

Dimension	Taiwan			China		
	$\chi^2$	P-Values	Significant difference	$\chi^2$	P-Values	Significant difference
1. Customer portfolio management	5.835	0.212	No	6.137	0.189	No
2. Value proposition design	8.380	0.079	No	24.041	0.000	Yes
3. Value-added role	6.649	0.156	No	38.657	0.000	Yes
4. Reward and risk sharing	4.186	0.381	No	28.229	0.000	Yes

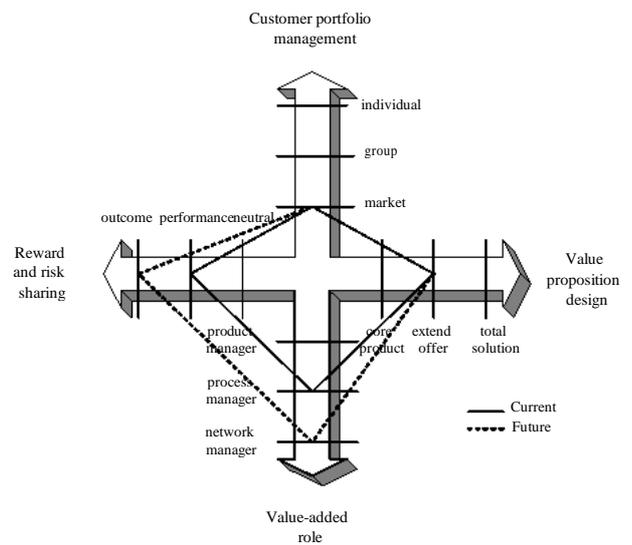


Figure 3 The value compass in China

After doing deep interviews, there were some suggestions coming out in the following.

- (A) Build it and they will come strategy: Adding franchise stores to expand market share and targeting the right market with the right product and image.
- (B) Appreciate the customer's value criteria and decision-making process strategy: Collaborative marketing with the famous brand in European to get into China market.
- (C) Add value for both buyers and sellers by providing a form of connection more efficient than either could achieve by operating independently: Using Application Service Provider (ASP) model to help franchise stores get significant information, search, or transaction costs.

(D) A mutual investment by both the buyer and seller strategy:  
 Expanding in Taiwan and China toward SPA new image stores, with encouragement of franchised beautification stores into franchised SPA chains.  
 (2) Customer connection strategies

In Figure 4, a comparison of how the franchise stores in Taiwan and China consider about their customer connection strategies is shown. Based on the surveyed data, the franchise stores in Taiwan have done the connection for customer knowledge in 64.17%, for customer connective technologies in 70% and for customer economics in 75%. On the contrary, the franchise stores in China have done the connections for customer knowledge in 70.94%, for customer – connection technologies in 65.76% and for customer economics in 64.55%. Interestingly, the franchise stores in Taiwan are doing better for customer connective technologies and customer economics. The franchise stores in China are doing better for customer knowledge. There will be something they can learn from each other and totally make profit for the beauty enterprise.

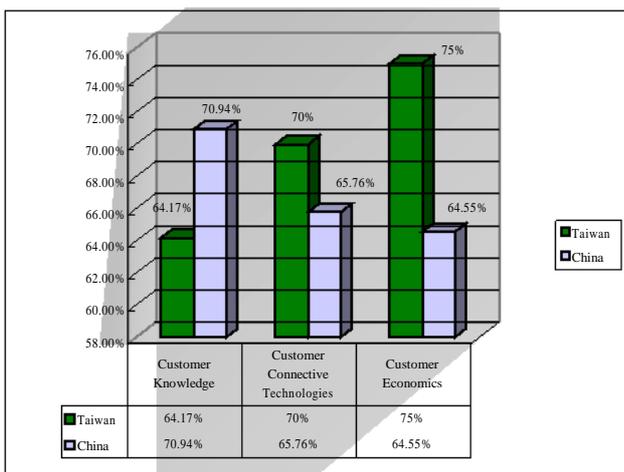


Figure 4 Customer connection strategies in Taiwan and China

## 5.2 Process analysis of KCRM

According to H<sub>3</sub>, H<sub>4</sub>, H<sub>5</sub>, Table 4 has shown responses about the process analysis of KCRM in Taiwan and China. So there is significant difference between Taiwan and China in the KM dimension expect knowledge store. It is important for the franchise stores to focus on knowledge create and share in Taiwan and knowledge store and capture in China.

According to Table 4, there is significant difference between Taiwan and China in the customer resources and categories dimension. It is really needed to take care of sharing knowledge sources and categories. Eventually,

the respondents of the franchise stores in Taiwan want to get more knowledge about best practices and problems. The respondents of the franchise stores in China want to get more knowledge about products and services and markets.

According to Table 4, there is significant difference between Taiwan and China in customer knowledge management hard and soft measures dimension. As shown in Table 5, the respondents of the franchise stores in Taiwan believe that well customer knowledge management is good for repeat purchases, customer retention and market share in the hard measures. The respondents of the franchise stores in China believe that well customer knowledge management is good for market share and repeat purchases in the hard measures. About the soft measures, the respondents of the franchise stores in Taiwan believe that well customer knowledge management is good for customer satisfaction, customer loyalty, customer and employee productive and organizational change. The respondents of the franchise stores in China believe that well customer knowledge management is good for customer loyalty and employee loyalty.

## 6. Conclusion

This research presents application of Knowledge-enabled Customer Relationship Management and takes a beauty enterprise as an example. This paper can be summarized in the following.

- (A) There is significant difference between current and future position in value proposition design, value-added role, and reward and risk sharing dimensions of the value compass model in China.
- (B) In this case study, the franchise stores in Taiwan are doing better for customer connective technologies and customer economics. The franchise stores in China are doing better for customer knowledge. There will be something they can learn from each other and totally make profit for the beauty enterprise.
- (C) Developing the process of KCRM, it is important for the franchise stores to focus on knowledge create and share in Taiwan and knowledge store and capture in China.
- (D) The respondents of the franchise stores in Taiwan want to get more knowledge about best practices and problems. The respondents of the franchise stores in China want to get more knowledge about products and services and markets.
- (E) Well customer knowledge management is good for repeat purchases, customer retention, market share, customer satisfaction, customer loyalty, customer and employee productive, organizational change and employee loyalty.
- (F) KM can enable CRM and help the CRM implementation.

Dimension		Mean <sub>Taiwan</sub>	Mean <sub>China</sub>	t-Values	P-Values	Significant difference
Knowledge Management	Knowledge Select	3.68	3.23	2.854	0.005	Yes
	Knowledge Capture	3.73	3.32	3.210	0.002	Yes
	Knowledge Share	3.76	3.25	2.981	0.004	Yes
	Knowledge Create	3.89	3.29	4.094	0.000	Yes
	Knowledge Store	3.55	3.39	2.239	0.220	No
Knowledge Sources and Categories	Markets	4.00	3.31	5.422	0.000	Yes
	Competitors	3.48	2.74	4.714	0.000	Yes
	Customers	4.03	3.30	5.342	0.000	Yes
	Orders	3.86	3.14	5.328	0.000	Yes
	Contracts	3.90	3.19	4.638	0.000	Yes
	Products and Services	4.03	3.44	3.838	0.000	Yes
	Problems	4.08	3.23	5.538	0.000	Yes
	Best practices	4.11	3.25	5.975	0.000	Yes
Customer Knowledge Management Hard and Soft Measures	Hard Measures	3.80	3.24	4.867	0.000	Yes
	Soft Measures	4.05	3.49	4.779	0.000	Yes

Table 4 Process analysis of KCRM in Taiwan and China

Table 5 Customer knowledge management hard and soft measures

Hard Measures	Mean <sub>Taiwan</sub>	Mean <sub>China</sub>	Soft Measures	Mean <sub>Taiwan</sub>	Mean <sub>China</sub>
Cost savings	3.77	3.23	Customer satisfaction	*4.13	3.59
Customer retention	*4.10	3.39	Customer loyalty	*4.13	*3.68
Repeat purchases	*4.17	*3.42	Customer and employee productivity	*4.13	3.62
Market share	*4.10	*3.55	Employee loyalty	4.07	*3.64
Customer acquisition rate	3.33	2.32	Employee empowerment	3.97	3.44
Cost of sales/expense reduction	3.70	3.35	Defection likelihood	3.83	3.33
Stock valuation	3.80	3.30	Market leadership	4.10	3.48
Bottom-line effects	3.37	3.09	Organizational stability	*4.13	3.32
Profit margins	3.90	3.52	Cultural change	3.97	3.30

## Reference

- [1] ARTHUR ANDERSEN BUSINESS CONSULTING (1999) Knowledge Management: Jissen No Tame No Best Practice (Tokyo, Toyo Keizai).
- [2] BECKMAN, T. (1997) A Methodology for Knowledge Management, Proceeding of the TASTED International Conference on AI and Soft Computing.
- [3] LESSER, E., MUNDEL, D. & WIECHA, C. (2000) Managing customer knowledge, Journal of Business Strategy, November/December, pp. 35-37.
- [4] DAVENPORT, T. H. & PRUSAK, L. (1999) Working Knowledge –How Organization Manage What They Know (Boston: Harvard Business School Press).
- [5] LIN, Y. (2000/2001) Assessing the applicability of integrated communications- a systemic view, Journal of Integrated Communications, pp. 46-51.
- [6] LYU, J. & LIN, Y.C. (2001a) A strategic application of customer relationship management, Quality Control Journal, March, pp. 21-24.
- [7] LYU, J. & LIN, Y. (2001b) Applications of CRM on SMEs- A Field Study on the Steel Industry (Chinese Taipei, Hsinchu, APEC Small and Medium Enterprise E-Commerce Symposium), pp.157-170.
- [8] LIN, Y., SHU, C., HSIEH, H.H. & SHIH, W. (2001) A Field Study of CRM and Hotel Enterprises, The First International Conference on Electronic Business, Hong Kong, P.273-274.
- [9] MASSEY, A.P., MONTOYA-WEISS, M.M., & HOLCOM, K. (2001) Re-engineering the customer relationship: leveraging knowledge assets at IBM, Decision Support Systems, 32, pp.155-170.
- [10] SHAW, M.J., SUBRAMANIAM, C., TAN, G.W. & WELGE, M.E. (2001) Knowledge management and data mining for marketing, Decision Support Systems, 31, pp.127-137.
- [11] TIWANA, A. (2000) The Essential Guide to Knowledge Management, E-Business and CRM Applications (Upper Saddle River, Prentice-Hall).
- [12] WAYLAND, R.E. & COLE, P.M. (1997) Customer Connections: New Strategies for Growth (Boston, Harvard Business School Press).

# Analyzing the Functional Frame of eCRM Based on Customer Value

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## Abstract

eCRM ties customer relationship management with the e-business. This paper suggests the functional frame of eCRM should base on the customer value to realize the win-win strategy for both the companies and their customers. The main functions to support these are explained and a functional frame model is proposed.

## 1. Introduction

No other inventions in recent years can have such a deep influence like the Internet to the companies on how to management their customer relationship and how to do business. The use of network has greatly changed a customer's purchase expectation to convenience, speed, price and service. Internet provides totally a new way of doing business in this century.

More and more customers now purchase goods through Internet, but this is not the only influence of Internet to the customer behavior. Customers also search for information's about products, services and other related things through Internet before they make a purchase decision, and enjoy more services that the companies offered on their service web sites. Companies have to rethink about how to tighten the relationship with their customers by creating the e-business strategy.

eCRM ties customer relationship management with e-business. We can expect eCRM may have a rapid growth in the near future. However, what should the eCRM functional frame be? Is it purpose merely to realize the marketing, sales and customer service automation through Internet technology?

We think the automation is the basis for eCRM operation, but the main propose of customer relationship management should be the realization of the customer value. Here the customer value means not merely the value that customers provide to companies, but also the value that companies can provide for their customers. Therefore, when we build an eCRM functional frame, we first should consider how to realize the customer value for both sides. A successful eCRM should effectively support the company to realize the win-win strategy in the Internet Era.

In this paper, we first state the customer value as the core of eCRM. Then the content of customer value is discussed from what customer requires and what customer returns. Third, based on the customer value, the main functions for supporting the realization of customer value

are suggested and a functional frame model is proposed.

## 2. Customer Value: Core of CRM

People usually classify the CRM software products by their main functionalities to three types: the Operational CRM, the Analytical CRM, and the Collaborate CRM. The operational CRM is a customer-orient application, which is something like parts of ERP's function. It not only strengthen the relatively weaken part of sales function in the ERP, but also integrate the marketing and customer service function as a whole. The analytical CRM captures, stores, extracts, processes the customer data and publishes the corresponding paper by using the data warehouse and data mining technology, so to discover the new customer knowledge for the company. The Collaborate CRM provides collaborate working environments across all the customer touchpoints.

Currently there are many CRM softwares available in the market, including the eCRM applications. However, we can see that most of them still function as marketing, sales, and customer service automation and integration tools. Although there are more or less customer management functions in them, those functions looked more like customer information management systems than customer relationship management.

The automation and integration of marketing, sales and customer service contribute to company's front-office automation, and it is the basis to run the customer relationship management, but not the core. We all know that today's market goes from product centric to customer centric, a customer driven business requires a clear knowing to the customer value. Some acknowledged marketing and management theories on CRM suggest CRM bring value to the company through these ways:

First, it should bring the capacity of "one to one marketing" to the companies. Companies should classify their customers base based on the value each customer brings to the company, and provide different service to them.

Second, based on the "80%-20%"rule, to keep an old customer is more profit than to acquire a new customer, so, companies should turn from the focus on opening new marketing to the focus on keep their loyalty customers and make them more profitability

These methods focus on the value that customers bring to companies, but this is not the all, CRM should not merely consider the value that the customers provide to companies, but more important is the value that the

customers need! Customers wouldn't keep relationship with companies if their own value requirement cannot be satisfied; this is more prominent in today's customer centric era. So, a successful CRM should first focus on the value that the customer required, consider what value can the companies provide to their customers, how can these values be provided to their customers. CRM should first manage customer value by providing customers with their required value, and to gain customers' return value. This is the win-win key for a successful CRM. To management customer value and realize it should be the core of CRM.

In the eCRM environment, Internet provides the convenience and flexibility for a customer to browse information, purchase goods and get services, it also provides the companies the power to provide information about products and services quickly to their customers, and to monitor their customers online more effectively. Whereas, Internet also carries a situation that people never meet before, that companies and their customers wouldn't communicate face to face as before, but just through a computer network. How to deal with the changes and how to realize the customer value is the problem that eCRM should face. This problem needs effective functions to meet the customers required value and make a good use of customers return value.

### 3. Customer Value Analysis

To get a clear understand on the contents of customer value, here we analyze customer value based on both customers' required value and their return value to the company.

#### 3.1 The Customer Required Value

The propose that customer buy a product is to get its use value, but this is not the all, customer has requirements during all the process —from product selection, purchase to usage, these requirements form the customer's additional value requirement. We now discuss the customer's value requirement by dividing the customer interaction process into three periods: pre-purchase period, in-purchase period and post-purchase period.

##### 3.1.1 Pre-purchase Value

The diversification of products and the mass of information make it difficult for the customers to make their purchase decisions, customers have to spend considerable quantity of time and energy, sometimes even money to seek and acquire the useful information to help them choose the proper products.

We call the cost arisen during customer's product seeking activities as the seeking cost. It contains the time, energy and money consumed during the product seeking process, besides, the risk cost of choosing wrong product also included. Lower down the seeking cost means the customer can choose product more fit for use while spend much more less time, energy and money in it. So, the value that customer requires during pre-purchase period is to minimize the seeking cost.

##### 3.1.2 In-purchase Value

Once customer makes a choice, the value he requires will transfer to the purchasing process. The common expectations to the purchasing process are: (1) Convenience, that he can place a purchase order through a convenient way, for example, he can buy it on the web, not necessarily going abroad. (2) Simple ness, the purchase procedure won't be so complex. (3) Timeliness and accuracy, means that the product he buys can be sent to him as soon as possible and the product delivered is the right one he wants. (4) Flexibility, which means some flexible payment ways can provide to customer. The value requirement during purchasing period is to maximize the expectation utility.

##### 3.1.3 Post-purchasing Value

Companies appear to know their customers' needs after the products sold, so this is a common scene for companies to provide after service for their customers. After-service is an effort by companies to meet their customers' post-purchasing period value requirements. The post-purchasing period value requirement is to pursue the minimization of risk cost of the product use. The risk cost includes the probability of consumption in the product maintenance and repair, and the lost due to the incapable of product use.

The pre-purchase value requirement, in-purchase value requirement and post-purchase requirement form the process value requirement, here the word process represents the companies' relationship process with their customers. The customer required value includes two important parts: the process value arisen from the relationship and the use value brought by the product. Though the use value is determined by the nature of product, it is apparent that high process value can take a positive improvement to use value. Figure 1 shows the construct of customer required value.

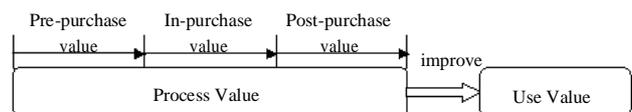


Figure 1: The construct of customer value

#### 3.2 The Customer Return Value

The customer return value is the value that customer contributes to the company after his own requirement is fulfilled. The main value within the return value is, of course, the money value that customer brings to the company. The money value consists of three parts:

- y History value: The value that has been realized until now.
- y Current value: The future value that the customer can bring to the company if his current behavior pattern keeps unchanged
- y Potential value: If customer's purchasing enthusiasm can be raised by company's effective marketing and sales means, he might provides

more value to the company than ever.

Currently more and more companies are prone to care not just the temporary profits that their customers brought to, but the long-term profits through the whole customer lifecycle, which is called the customer lifetime value, abbreviated as CLTV. CLTV is the net value of all the revenue a customer contributes minus all the cost relevant to the customer.

A loyalty customer can bring more value to the company other than the increase in profit, these mainly include the cost saving and the word of mouth. Cost saving is the result of an effective cut down in marketing and transaction cost. While a good word of mouth may grow the company's good will to the society and leave a favorable image to company's prospects.

#### 4. An eCRM functional frame analysis

The eCRM should well support a company to realize its win-win strategy under Internet environments. So its functionality settlement should be based on the customer value that we discuss above.

Based on customer value, the functionality of CRM should include customer support and customer segmentation.

##### 4.1 Customer Support

It is essential for a company to provide more process value for its customer to gain a competitive edge. A well-designed customer support functionality can help to win it. These functions or modules may be as follows:

###### (1) Customer Decision Support

In most cases, customers like to find out a way that can make their seeking cost the lowest, such as asking an experienced friend. Now the information available on Internet is so abundant and easier to access, more and more customers are used to find out information about the products before they make a purchase decision or go out to the street.

The troubles caused by much too many information won't be simpler than those caused by too less information available. Customers have to find out something useful among the huge searching results, which lower the seeking efficiency and make it difficult for customers to make a decision. Therefore, the effective way to lower a customer's seeking cost is to import a customer decision support system into CRM. Here customer decision support means to help customer:

Identify the product range that fits his needs.

Know the advantages of the company's products comparing to the competitors.

Choose a proper product from the company's product list.

This is not a new idea. In fact, there are many resources; especially a lot of web sites on Internet are helping people to make a good purchase decision. The help forms include providing a purchase guide, a comparison among the leading products, and a final purchase solution. This kind of help is actually to make

information collection, classification and analysis for the customer, so that they don't have to waste time and energy to do this work, thus effectively lower their seeking cost.

To give a decision support for the customer is meaningful to a company's marketing strategy. Based on the minimization of seeking cost rule, the probability that a customer comes to buy or inquire is larger if he thinks this company can effectively help him to make a right decision on purchase.

This work may be miscellaneous, but not difficult for the realization in technology. To build a customer decision support system maybe not as complex as a truly decision support system that can help a top manager to make decisions, but actually companies take less notice of it. To give customers help in the pre-purchasing period is an aspiring manifest in concerning the customer's requirement value.

###### (2) Purchase checking and monitoring

There exist many differences between the purchase online and the traditional purchasing patterns, some may bring troubles to customers while some are favorable to them.

If the product that a customer wants to buy is out of stock, then he may want to know when it can be available again. If the customer is doing shopping with a company's sales employee, he could get this information from the employee, but on a web site, often he is just get a notice that this product is OOS. It is the same in the situation while the available quantity of product is less than what the customer wants.

After placing a purchasing order in a web shop, a customer needs to wait for the company delivers. The customer wants to know whether his order is accepted and being processed, when can his product be sent to, is it right on the way?

To meet a customer's purchasing requirement, a purchasing check and monitor system should be incorporated in the CRM system to provide him with these capabilities.

This cannot be done entirely by CRM, actually, it needs a cooperation with company's back end systems, such as ERP or SCM to get the information.

###### (3) Self-service

The Internet can provide a true 24×7 service capacity for the companies. The service web sites can provide such functions as a solution database, FAQs, resource downloads, E-mail answers for questions and so on. The future development of Internet self-service web sites is to cooperate with the customer interaction center so to strengthen the capacity of providing real-time service to the customers.

##### 4.2 Customer Segmentation

The purpose of a company to know its customers value is to segment its customer base based on the value they provide. Then the company can find its most valuable customers through recognize, identify and retain of customers.

The differentiation of service can lower down the

total service cost while ensuring the valuable customers that they can enjoy service that is more valuable. The functions that work through using customer return value can be as follow:

(1) Customer classification

Customer value management suggests viewing customers as an important asset for a company. The method of classifying and managing customers based on customer return value is an application of ABC analysis.

To identify the importance of a customer for the company, customer profitability is an important but not the only measure element. A more comprehensive way is to use the customer loyalty as an evaluate figure.

(2) Customer behavior analysis

Customer behavior analysis is used to analyze the customer's purchasing behavior. Applying the data mining methods to customer data to segment customer base, and define the cross-selling product association rules. We can also use the RFM analysis to optimize the business campaigns.

Customer behavior analysis can also be used to determine customer's churn propensity. Using the data mining methods to analyze the history data and identify which type of customer behaviors often happen frequently before customer leaving the company, and define these behaviors as the alert for customer churning.

(3) Customer intention analysis

Different from the history record based customer behavior analysis, the customer intention analysis is to forecast the customer's future intention. The data that this analysis used comes from the feedback information through proactive customer interaction.

Forecast can help companies to know their customers' latent thought, to know what customer needs in the first time, and put these demands into the product or service development process; or use this information to propose more suitable products to their customers. Through the real-time monitor of customers' attitudes to satisfaction during the customer interaction process, companies can make a more precise evaluate on how their products can be accepted by their customers, and find out the problem during the process in time, then a more accurate forecast to customer churn can be made.

To collect more elaborate customer feedback information through CRM system environment, thereby forecast the customer's intention seems to be a common sense. However, customer intention analysis is still not an emphasis on customer relationship management, at least current developed applications don't think much of it. To integrate the true customer voice into a company's business process is a slow process which a high technology and a plenty of money is required. Consequently, many companies still make their customer analysis and decision based on the past sales data and history records.

In fact, customer intention analysis has existed in other forms for many years. Tools such as customer visit, telephone inquiry and personalized talking are all used to do this task. Internet even provides a strong capability to

monitor customers' activities on line and make responses in time. Therefore, the work is to make a good use of these tools and capabilities through a system ways to build a systematic customer intention analysis system.

(4) Customer group segmentation

Customer group segmentation is a most important way for a company's marketing department to do company's market strategy. The development of data warehouse and data mining technology enables the companies to segment their customer base not simply based on the demographic data, the segmentation based on the customer behavior analysis and the customer intention analysis can be more precise and valuable.

(5) Personalized configuration

The customer master data together with the customer classification information and the customer analysis result can form a comprehensive customer profile. The personalized configuration is to provide different service solutions for different customer profiles, such as product-combined suggestion, pricing discount strategy and after-sales promise.

4.3 A Functional Frame Model

From a general prospect, the frame of an eCRM still takes the automation and integration of marketing, sales and customer service as its operation base. Working in the Internet environment, the feature of this model is to provide both customer support and customer segmentation functions for the customer required value and the customer return value. Figure 2 shows this model.

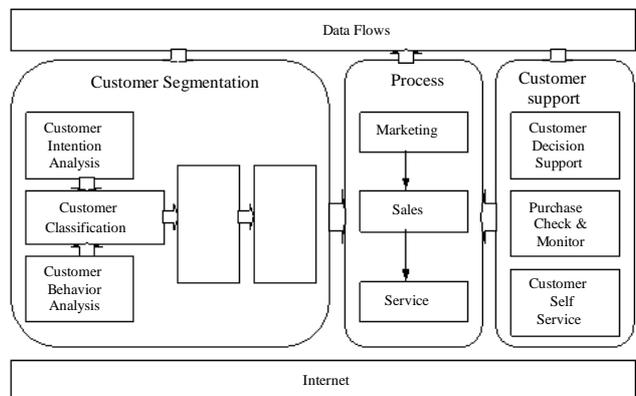


Figure 2: A functional frame model of eCRM

5. Summary

In this paper, we suggest the customer value should be the basis when we consider the function frame of eCRM. The first we should do is to realize the customer values by using it. The customer values include both the customer required value and the customer return value. Based on the content of these values, the main functions of customer support and customer segmentation operating on the Internet environment are explained and a function frame model is proposed. It is a way of thinking in an attempt to realize the win-win strategy for both the companies and their customers through Internet under the e-business environment.

## References

- [1] Paul Greenberg. CRM at the Speed of Light: Capturing and Keeping Customers in Internet Real Time. McGraw-Hill, 2001.
- [2] Wang Jiankang. "The CRM Value Chain in the Era of Internet," China soft science, 2001, 11,72~75.
- [3] Hu Zuo-hao, Zheng Zhao-hong. "The Concept of Customer Lifetime Value and Its Reveal to CRM," Foreign Economics & Management, 2001,4, 43~48.
- [4] Qi Jia-yin, Li Huai-zu. "Analyzing the Systematic Frame of CRM," Industrial Engineering Journal, 2002, 1, 42~45.
- [5] James G. Barnes. Secrets of Customer Relationship Management: It's All About How you Make Them Feel. McGraw-Hill, 2001.

# Linking Customer Retention to Intelligent Technology: An Optimization Approach

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## Abstract

Marketing managers in the telecommunication sectors are confronted with considerable complexity. They have to make decisions about the optimum combination of products or offerings, customer groups and the means of interacting with potential customers. Further, in saturated markets such as mobile telephony, it is increasingly important to retain customers potentially to churn.

On the optimal campaign planning, this research describes how the customer survey was conducted for those potentially churning customers based on which an optimal campaign planning was followed. This research engages with the subjects of customer retention from the perspective of a major mobile operator in Taiwan. Customers' preferences with C&C (campaign offer and communication channel) were predicted and input for further analysis for target selection optimization. These models were proved novel in an organizational prototype project suggesting that the use of the hybrid of data mining and optimization approaches can be effective for target selection.

## 1. Introduction

According to the ITU world telecommunication indicator database [1], the mobile telephone penetration rate in Taiwan had reached 97% at the end of 2001. This is the second highest level in the world and has resulted in a highly competitive market place for providers. It is both difficult and costly for the operators to acquire new customers when a market demand is so highly saturated. So, one of the key success factors for the operators is their ability to retain high value customers. To do this they need to understand, in depth, the behavior of customers and to use this information effectively to support successful retention campaign activities.

Artificial Intelligence (AI) technologies offer a way of achieving this knowledge. These have a number of underlying reference disciplines such as biology, neurology, psychology, statistics, and computer science, and have increasingly been applied to various types of problems. Because of advances in IT technologies, the power of AI approaches has increased dramatically.

These techniques offer the business community a

broad set of tools capable of addressing problems that are much difficult, or impossible, to solve using the more traditional technologies from statistics and operations research. However, these AI technologies are not commonly employed in business generally, largely because many organizations are not adequately prepared to capitalize on a technology driven environment.

This paper focuses on customer retention from the perspective of the major mobile operator. Its purpose is to explore the applicability of AI techniques in the customer retention campaign design process. A hybrid of data mining and optimization techniques is developed for target selection in order to retain valuable customers. The paper has five following sections. The first provides a brief review of the literature on customer retention, customer equity, customer data analysis approach, target selection and budget allocation, artificial intelligent techniques and genetic algorithms. The second describes the background of the decision problems of the mobile operator. In the third, the methodology used to is described and this is followed by the results, a discussion including limitations of the study and suggested areas for future research.

## 2. Literature Review

### 2.1 Customer Retention

A traditional marketing approach advocates the quest for market share dominance through mass marketing techniques and focuses on new customer acquisition. This approach has guided managers for decades in planning and implementing their marketing strategy. However, attention is drawn by some researchers to the inadequacies of the traditional marketing approach, and this has led to the birth of relationship marketing (RM). RM advocates supplier-customer interaction and the maintenance of long-term relationships with a focus on customer retention. Based on their consulting experience, Reichheld and Kenny [2] claimed that a 5% increase in retention rate led to profit swings of 25% to 80%. Ahmad and Buttle suggest that practitioners need to move beyond gaining a larger market share, to satisfying market segments and developing brand preference in order to secure lasting customer patronage and profitability [3]. They believe that firms should consider integrating customer retention into

their strategic market planning processes and set it as one of their primary goals .

## 2.2 Measurement of Customer Equity in Retention

Even after having accepted the importance of customer retention, managers are left with the issues of which customers to retain and what is the appropriate metric on which to base decisions. Some researchers stress the importance of customer value as a measurement of customer retention [3][4]. Others take a more long term view and have proposed the “Customer Lifetime Value” (CLV), also referred to as Customer Equity [5], as a method of measuring customer value. The basis of a CLV approach is the “excess of a customer’s revenues over time over the company costs of attracting selling, and servicing that customer” [6]. Berger and Nasr [7] present mathematical models for determination customer lifetime value and their models have been often referenced by researchers [3][8]. Although in theory CLV is a useful form of measure, in practice it is difficult to implement. The difficulty lies in the lifetime construct because lifetimes are variable. In this study, the customer value measurement was based on the literature and additionally according to our domain manager’s experience and data availability. For example, an age variable was used instead of estimating a lifetime for each customer.

## 2.3 Approaches to Analysing Customer Data

Demographic and behavioral data are very useful in describing customers and have an important place in direct marketing decisions but they provide little insight into understanding the needs that motivate and shape the purchase process [9].

As Compared with the more ‘objective nature’ of demographic and behavioral data, needs-based data reflects more psychologically abstract dimensions of consumer segmentation. The use of buying motive and benefit data are appropriate inputs for segment-specific product decisions, promotion decisions, and target marketing decisions [10]. Segmenting markets by consumption patterns can be quite insightful for understanding the customer mix, as by classifying customers into usage categories; management can design appropriate strategies for each market segment [4]. In the current study, the needs-oriented data about consumer preferences on different retention offers and communication channels were obtained by survey. The experimental framework (Figure 2) was designed using two approaches in building C&C models, with and without segmentation. Then the prediction performance of two approaches was compared.

## 2.4 Target Selection and Budget Allocation

Most of the literature on target selection focuses on the issues of response model of direct mail. This study focuses

on target selection of multiple channels . The process of target selection in our experiment is defined as a prior process before building the response model of direct mail. In our experiment, direct mail target customers were determined by the C&C prediction model and target selection model. However, a customer who prefers a specific channel does not necessarily mean he/she will respond to the content delivered by the channel. If a response model is expected, it can be built after finishing the target selection process. Related research on response models can be referenced in [11-13].

In general, target selection in customer retention tends to maximize customer equity under resource restriction. This resource restriction associates with the retention process lies in promotion budgets, call center labor capacity, or other medias channel capacity. Berger and Nasr present a model focusing on promotional budget allocation decisions between acquisition and retention in an organizational level. They assume that a promotional budget has been already set, and they address the optimal allocation of this preset budget [14].

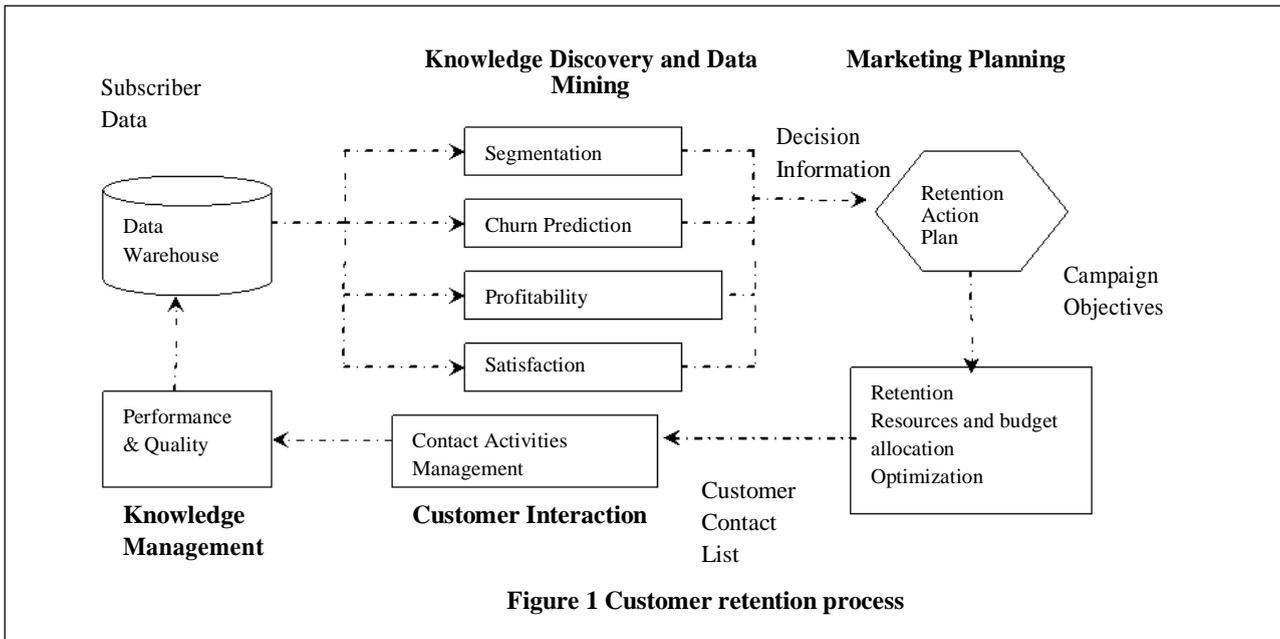
In the current study the decision problems were being made where the retention promotion budget was either undetermined or determined; and the goal was to optimize the budget allocation in an individual level.

## 2.5 Artificial Intelligence Techniques

Increasingly, work is becoming “knowledge oriented”, with a growing number of “knowledge workers” in organizations required to work with information- gathering, summarizing and interpreting - in order to make decisions. AI can play an important role as a powerful analytical tool to this knowledge oriented working environment.

With the improvements in storage and processing capacity of computers in recent years, artificial intelligence (AI) derives its power to offer the business community a broad set of tools capable of addressing problems that are much harder to solve using traditional techniques from statistics and operations research [15].

Another terminology related with AI technique is data mining. Data mining brings together ideas and techniques from a variety of fields that are similar to AI. Statisticians, artificial intelligence researchers, database administrators, and marketing people used different words to mean the same thing and the same words to mean different things [16]. Data mining frequently uses a variety of AI and statistical techniques for solving problems, but the approach of data mining is more grounded in the methodology than just in the techniques. Data Mining, or AI, is good at solving tasks related with classification, estimation, prediction, affinity grouping, clustering and description. Typical examples of these techniques are Genetic Algorithms, Neural Networks, Decision Trees, Automatic Cluster Detection, Fuzzy Logic, Market Basket Analysis, Memory-Based Reasoning, and Rule-Based



Reasoning [15] [16].

Companies use information in their customer relationship management (CRM) strategies. Data warehouse and data mining techniques allow companies to collect, store, analyze and manipulate enormous volumes of data. This can be important for marketers trying to provide better service to retain more customers than competitors. A survey of 40 companies in UK [17] shows that few companies are adapted in using such approaches and that there is a need for more applied research using AI techniques in business.

### 2.6 Genetic Algorithms and Target Selection

Roberts and Berger [18] discuss the most frequently used models to select targets for direct mail. Among these are multiple regression analysis, multiple discriminate analysis, log-linear modeling, and chi-square regression automatic interaction detection (CHAID). More recently target selection has used a neural network model [13].

Hurley et al. [19] suggest some potential marketing research can employ genetic algorithms. Targeting and optimization of distribution channels are among them. Bhattacharyya [20] presents a genetic algorithm-based approach for obtaining models in the area of direct mail. This paper is unusual in its application of genetic algorithms to the process of target selection although doing so is still within the scope of a response model to direct mail.

Traditional use of optimization methods assumes that a 'best solution' can be generated. These methods are not well suited to less structured problems, where the desired objectives are not known in advance [21]. Many real world decisions problems are unstructured. In less structured problems, the conditions indicating the existence of problems are not defined; there is no best methodology to solve these problems, and the criteria for choosing the optimized decisions are not clear [22].

desired characteristic of a decision support approach is to provide diverse alternatives for consideration. A Genetic Algorithm (GA) is good at generating diverse alternatives in such unstructured problems. GAs can also deal with problems that incorporate nonlinearity, discontinuity, uncertainty, complexity, and other demands which make the application of traditional search and optimization methods inappropriate [21]. In this study, target selection in customer retention is characterized by searching for alternatives of budget allocation in offer-channel-customer combinations to achieve the optimization of objectives under multiple constraints.

In the current study, the target selection is achieved by genetic algorithm that involves decision making with a budget allocation and offer-channel combinations.

### 3. Background of ABC Company

Six operators provide mobile service in Taiwan. Table 1 shows that the number of Taiwan mobile users grew tremendously between 1998 and 2002 - almost 500%. Over this period, average revenue per user (ARPU) has fallen by 33%, minutes of use per user (MOU) grew for the first two years, and has been steady for the last three years. Obviously, this is a demand-saturated market. As for the past several years, mobile operators have competed for market share, that is, the acquisition of new customers has been the major market strategy.

**Table 1 Market data in Taiwan mobile service industry\*\***

	1998	1999	2000	2001	June, 2002
Penetration Rate %	21.46	52.24	80.24	96.55	102.69
MOU	689	828	884	883	415
APRU	11725	9118	8492	7892	3838

\*\*Penetration Rate = Total number of mobile users / Total number of population in Taiwan  
 MOU = Minutes of use per user  
 ARPU = Average revenue per user, measure unit = Taiwan Dollar (NT)  
 Source: Direct General of Telecommunication Taiwan (www.dgt.gov.tw)

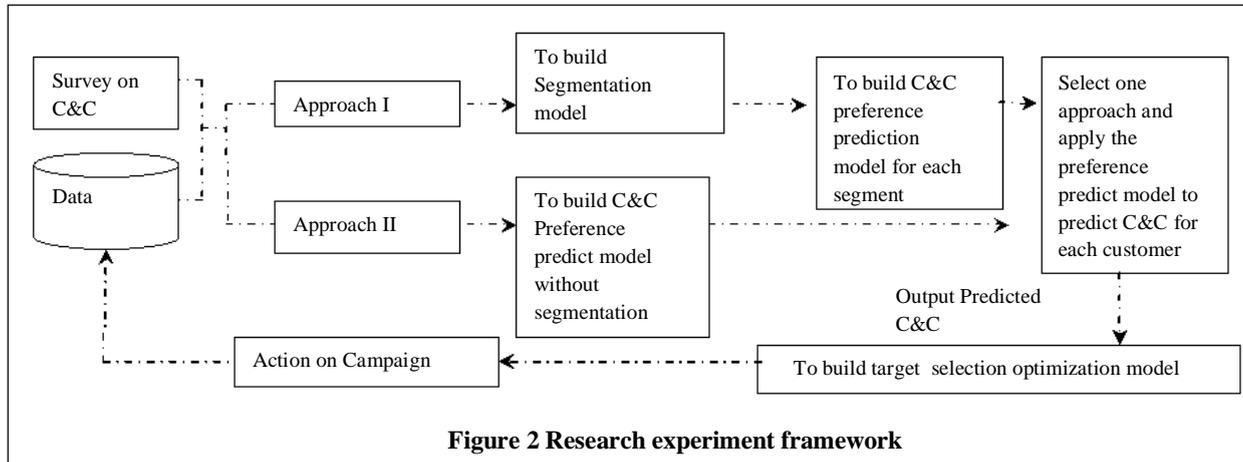
complex because of different offer-channel combinations.

The company initiated a prototype project to explore solutions to the above issues.

## 4. Methodology

### 4.1 Research Experiment Framework

The research framework adopted the steps in Figure 2:



However, the competitive environment has forced the ABC to adjust their marketing strategies and refocus their business strategies on retaining - rather than acquiring - customers.

In order to understand the defection status of their customers, the ABC company has implemented a churn prediction model based on the framework for Customer Retention process shown in Figure 1[23]. The process shows that data in data warehouse can be used to analyze customer behavior from several perspectives, including segmentation, profitability, satisfaction, and defection (churn). A churn prediction model is a logical output as it is important to understand which customer is likely leaving, and why, so that retention initiatives can become more focused. A churn prediction model aims to aid in the development of more accurate estimate information for use in subsequent retention campaigns. The focus in this paper is on the next step process - retention action plan.

The company intends to retain customers identified as having a high likelihood of churn. To do this the following considerations have to be met:

1. The output name list of churn prediction model, normally around 5000 customers, is too large to be managed and needs to be reduced. The basis for the reduction is unclear.
2. A retention offer which meets customers' preferences and hence achieves a higher retention needs to be formulated.
3. The desire is to announce the retention offer through the communication channel which mostly meets customers' preferences.
4. Budgetary allocation for the retention program is

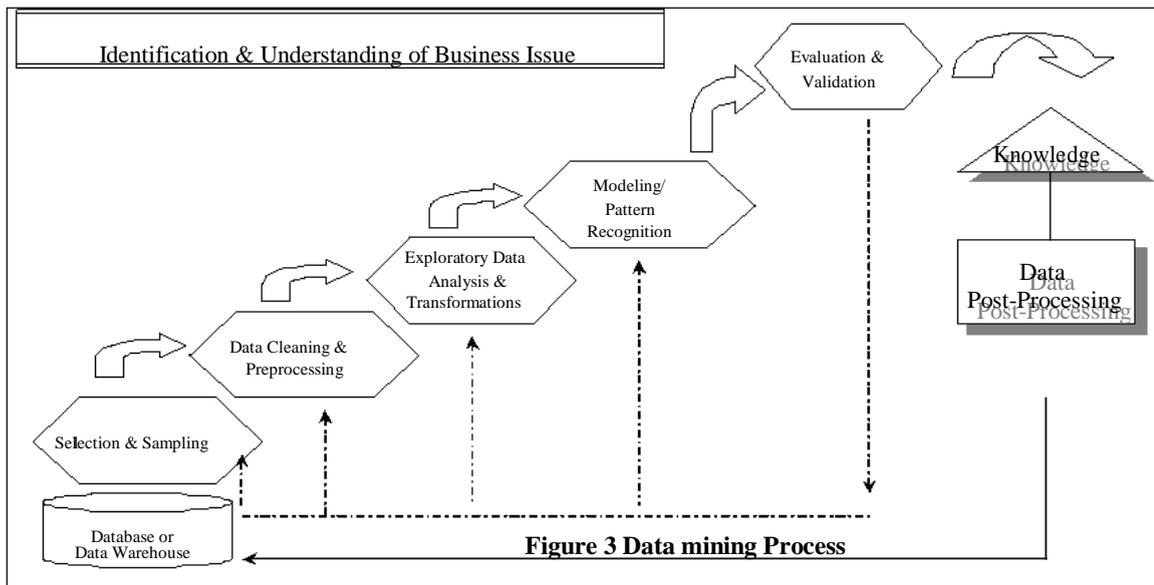
1. A survey to collect information on customers' preferences on campaign offers and communication channels.
2. The integration of customer preference data from survey, and customer data from data warehouse, to build a customer C&C predictive model.
3. Two approaches were designed. Approach I involved building a segmentation model first and then building C&C models for each segment. The major premise behind this needs-based segmentation approach was that by segmenting customers into various user groups, management could develop appropriate strategies for each market segment [10]. Approach II involved building the C&C model without considering segmentation. This is a much quicker way to build C&C model.
4. Comparison of the predicted performance of the models, and choosing the model with best performance.
5. Application of the models to a customer population to provide a prediction of the preference C&C for each customer.
6. Using data predictions, to build a target selection model to evaluate and differentiate budget-offer-channel combinations. The model will search for a series of good (optimal) solutions under resources constraints, and optimize some presetting business objectives.
7. To take action on retention campaign programs targeting customers selected from the target selection model.
8. Evaluation of the campaign performance from data in data warehouse.

Steps 7 and 8 were not undertaken in this study.

## 4.2 Campaign Offer and Communication Channel(C&C) Mode 1

### 4.2.1 Data Mining Methodology

Fayyad's process [24] was followed as shown in the Figure 3.



### 4.2.2 Data Collection and Preprocessing

A population of 4481 (February, 2002) customers with a high churn propensity were provided by ABC company. Six hundred (600) customers were randomly surveyed by mail. Three main questions were asked:

- Which retention offer do you prefer?
- Which communication channel do you prefer to receive our notice of promotion activity?
- What are potential reasons will cause you to decide to leave your current operator?

Five retention offers were designed by the company. These offers are related with handset subsidies, free traffic minutes, prepaid discounts, special gifts. Four communication channel options were presented including email, DM mailing with monthly invoice, short message, and outbound call from sales representatives. Two hundred and sixty one (261) questionnaires (43.5%) were returned within fifteen days of mailing.

Customer data were extracted from data warehouse, Details for individuals included demographic information (age, geographic code, etc.), rate plan, transaction apply items, tenure, credit record, churn score, complaint records and usage information.

A preliminary statistical analysis was performed to enhance familiarity with the data and to detect and remedy any missing values or outliers that might distort the

subsequent analysis .

### 4.2.3 Data Mining Approach

With the initial analysis completed, knowledge discovery algorithms were applied to the data. The aim was to statistically identify the relationship between variables and dependent variables so that significant variables could be selected, derived and transformed, and

input into next modeling process. The total number of independent variables used for C&C modeling was 61 while one dependent variable (preference on retention offers or communication channels) existed.

The data was then divided into a training set and a testing set. This was done because it was important to ensure that our models do not merely memorize the patterns in the training set. The testing set confirms findings are valid and can be generalized to enable predictions to be made on new data. In the modeling process, decision tree and neural network training was applied to the prediction model.

In the modeling Approach I, the clustering algorithm - k means was used. Before the C&C modeling for each subgroup, the relationship of clusters with retention offers by independence test was examined. The purpose was to test if customer preference of retention offer was significantly different between subgroups. If so, the attributes of customers between subgroups is different and hence their preference of retention offer is different from other subgroups. If this was the case it would be appropriate to build a C&C model for each subgroup. If not, then a segmentation approach was not necessary, and Approach II was more appropriate.

The model performance of the decision tree and neural network methods was assessed and the superior approach retained. Then, the developed model was applied to the population to predict the preferred campaign offer and

communication channel for each customer. These predicted values will be used as input data of the optimization process for target selection.

### 4.3 The Optimization Model for Target Selection

With thousands of high churn propensity customers, the selection of retention targets is a difficult problem in practice. However, a GA can be used to optimize objective functions within constraints, and select retention targets under the following situation:

- (1) When the budget is undetermined, to provide several budget allocation alternatives with combinations of offer-channel-customer.
- (2) When budget is determined, provide several alternatives with combinations of offer-channel-customer.

#### 4.3.1 The Genetic Algorithm

GAs are good for solving optimization problems. The basic goal of optimization tasks involves finding one, or a series, of very good (optimal) solutions from among a very large number of possible solutions. Optimization problems involve three components: a set of problem variables, a set of constraints, and a set of objectives. These components can be transformed and operated by a GA.

GAs solve problems by borrowing a technique from nature evolutions. GAs use Darwin's basic principles of survival of the fittest, mutation, and cross-over to create solutions for problems. A GA consists of five main components:

The chromosomal representation, initial population, fitness evaluation, selection, cross-over and mutation.

A simple GA operation cycle is:

1. Generate initial random population
2. Evaluate fitness of current population
3. Select chromosomes based on fitness for reproduction
4. Perform cross-over and mutation give new improved population
5. Repeat 2-4 until stop criteria is met, the stop criteria may be set by number of trials, minutes of running time, a stop formula function or else.

A GA searches intelligently through the possible permutations. This is much more practical than searching through all possibilities. A GA allows a good solution to a problem quickly rather than waiting for the absolute best solution. Unlike many mathematical techniques, solution times with GA are usually highly predictable. Solution time is usually not radically affected as the problem gets larger, something which is not always so with the more traditional techniques. However this heuristic technique does not guarantee optimal solutions, users must often settle for "near optimal" solutions. [15]

#### 4.3.2 Problem Formulation

##### 4.3.2.1 Chromosome Representation

Each chromosome represents a possible solution for a selected group of customers. The individual genes with each chromosome are represented by a binary alphabet; 0 indicates that a particular customer is not selected, whereas a 1 would indicate that a particular customer is selected. To illustrate this, assume we have five existing customers, then the chromosome

11010

represents where customer 1,2,4 are selected and customer 3, 5 are unselected. In a case of one thousand customers, our chromosome will have a length of 1000 genes.

##### 4.3.2.2 Fitness Function

Fitness evaluation involves defining an objective or fitness constraints against which each chromosome is tested for its fitness, a high fitness value would indicate a better solution than a low fitness value. In this study, the fitness function was formulated as follows:

Maximize CVS (customer value score)

$$\sum_i \sum_j (W_1 * q_{CLV} + W_2 * q_{Tenure}$$

$$+ W_3 * q_{Payment\_Overdure} + W_4 * q_{Age\_Now}) X_{ij} \dots \dots (1)$$

Subject to the following constraints :

$$Tcost \leq MaxBudget$$

$$CusNum_i \geq MinCusNum_i$$

$$\sum_i PcusNum_i \leq MaxPcusNum$$

$$Tcost \leq \sum_i \sum_j (f(y) + f(z)) X_{ij}$$

$$0 \leq X_{ij} \leq 1, X_{ij} \text{ is an integer}$$

Where

$q_{CLV}$  Customer lifetime quantile value of  $X_{ij}$

$q_{Tenure}$  Tenure quantile value of  $X_{ij}$

$q_{Payment\_Overdure}$  The quantile value of the average invoice payment overdue days last six months of  $X_{ij}$

$q_{Age\_Now}$  The age quantile value of  $X_{ij}$

$W_1, W_2, W_3, W_4$  The weight value assign to each variable

$X_{ij}$  The customer  $j$  in the area  $i$ , it is the selection index of  $X_{ij}$  to retention program, if  $X_{ij}$  is selected as target then  $X_{ij}$  is set to 1, Otherwise,  $X_{ij} = 0$

$Tcost$  The total cost to execute retention program

$f(y)$  The cost function of retention offers

$f(z)$  The cost function of communication channels

$MaxBudget$  Maximum budget allocated to retention program

$CusNum_i$  Number of customers were selected in the area  $i$

$MinCusNum_i$  Minimum customers need to be selected as targets in area  $i$

$PcusNum_i$  Number of customers targeted through personal contact channel in area  $i$

$MaxPcusNum$  Maximum number of customers can be targeted through personal contact channel by call center

In summary, the objective of the target selection was to optimize Equation 1 the customer value score (CVS), subject to budget and resource constraints.

Equation 2 is the customer lifetime value (CLV) based

on Berger and Nasr's definition applied in this research:

$$CLV = C \sum_{i=0}^{n-1} \frac{r^i}{d^{i+1}} + M \sum_{i=0}^{n-1} \frac{r^i}{d^{i+0.5}} \dots \dots \dots (2)$$

where

$C$  = Yearly gross contribution

$M$  = Promotion cost per customer per year

$n$  = The length in years of period

$r$  = The yearly retention rate

$d$  = The yearly discount rate

Because the difficulties in defining  $n$  for each customer, for simplifying purpose, it was assumed that  $n = 0$ , thus

$$CLV = \sum_{ij} (C_{ij} + M_{ij})$$

and if  $M_{ij}$  is equal in each of  $X_{ij}$ , therefore,

$$CLV = \sum_{ij} C_{ij}$$

$C_{ij}$  = The yearly invoice contribution of  $X_{ij}$

Consequently a customer was judged only on current value with the yearly invoice contribution; however, the *Age\_Now* variable was set to reflect a customer's future value.  $W_1 = 1, W_2 = 0.4, W_3 = 0.2, W_4 = 0.1$  were assigned according to the company domain experts' experience. Negative values were assigning to  $W_3$  and  $W_4$  to represent the negative impact to the customer value score.

#### 4.3.2.3 Simple illustration

To illustrate the application of GAs to a target selection problem with a simple example, a population of five chromosomes is first randomly generated,

- $C_1$  11000  $C_4$  01100
- $C_2$  10001  $C_5$  10100
- $C_3$  10100

If the customer value score (CVS) calculated is,

- Customer 1 963 Customer 4 945
- Customer 2 953 Customer 5 605
- Customer 3 370

The fitness values (value of objective function) of chromosomes are:

- $C_1$  10000 fitness = 1916  $C_4$  01100 fitness = 1323
- $C_2$  10001 fitness = 1568  $C_5$  10100 fitness = 1333
- $C_3$  10101 fitness = 1938

Chromosome  $C_1$  and  $C_3$  are the fittest, so they would be

more likely to be selected for cross-over and mutation. If a one-point cross-over was used at a randomly chosen position, say position 3, the following offspring would be produced:

$$C_1 \ 11000 \ \square \ C_6 \ 11100$$

$$C_3 \ 10100 \ \square \ C_7 \ 10000$$

Their respective fitness values calculated are  $C_6 = 2891$  and  $C_7 = 963$ . Therefore, a new and better solution represented by chromosome  $C_6$  has been found.

The advantages in using a GA approach are:

- (1) An optimal or near-optimal solution is established in a predictable time.
- (2) The good alternatives can be accessed easily.
- (3) It is easy to apply, all that is needed is the ability to describe a good solution and provide a fitness function that can rate a given chromosome. This means that you can use a GA to solve problems that you don't even know how to solve!

## 5. Experiment and Results

### 5.1 The Survey Result

#### 5.1.1 Preference of retention offer

Table 2 shows the preference distribution of the retention offer and Table 3 the  $\chi^2$  values for independence tests for age, education and revenue factors. In Table 3, all the  $\chi^2$  values are smaller than  $\chi^2_{0.05}$  and  $\chi^2_{0.01}$ . This means that there is insufficient evidence to say that the preference retention offers differ on the basis of education, age, or revenue. However, from Table 2, it is obvious that the 'free minutes offer without prepaid' is the most favored retention offer overall.

**Table 2 The distribution of retention offer preference**

Retention offer type	%
Handset subsidies	20
Free minutes offer with prepaid	17
Free minutes offer without prepaid	56
Free mobile internet minutes offer	2
Special designed gift	5

**Table 3 The independence test**

Factors	$\chi^2$ value	$\chi^2_{0.05}$	$\chi^2_{0.01}$
Age	15.7	31.4	37.6
Education	25.0	26.3	31.9
Revenue	4.9	26.3	31.9

#### 5.1.2 Preference of Communication channel

Table 4 shows the preference distribution of communication channels and Table 5 the  $\chi^2$  values for the independence test with age, education and revenue. The preference of communication channel significantly depends on age at both  $\chi^2_{0.05}$  and  $\chi^2_{0.01}$ , and on education at  $\chi^2_{0.05}$ . Younger people (under 20) preferred only 'short message' and 'email', while for older people (above 50), these two forms were least preferred. The preference for personal phone contact increased with age. Also, people with higher education showed a greater preference for

'short message' and 'email' than people with lower education levels. From Table 4, 'DM with invoice' is the channel most often preferred, followed by 'short message'.

**Table 4 The distribution of communication channels preference**

Type of contact channels	%
Email	8
DM with monthly invoice	45
Short message	33
Personal telephone contact	14

**Table 5 The independence test**

Factors	$\chi^2$ value	$\chi^2_{0.05}$	$\chi^2_{0.01}$
Age	38.2	24.9	30.6
Education	24.7	21.0	26.2
Revenue	10.5	21.0	26.2

### 5.1.3 Potential Reasons to Churn

Communication quality and price were the top two issues that impact customer's potential churn behavior (Table 6).

**Table 6 Distribution of potential reasons to churn**

Type of reasons	%
Unsatisfied mobile communication quality	32
Cheaper tariffs with friends and relatives within same operator's network	15
Unsatisfied service quality	12
Better handset discounts from other operators	10
Price is higher than other operators	31

### 5.2 C&C Preference Model

In Approach I, before building the C&C modeling for each segment, the relationship of clusters with retention offers by independence test was examined, that is:

$H_0$  : Cluster is independent from retention offer preference

$H_1$  : Cluster is dependent with retention offer preference

However, the  $\chi^2$  value of 10.61504 was smaller than the critical value of  $\chi^2_{0.05} = 21.06$ , and so the  $H_0$  was accepted. Hence, it was decided not to build C&C model for each subgroup. This means that Approach II is applied to building the C&C model in this study.

By integrating the preference data from the survey with customer data in the data warehouse, and discarding some records with important missing data, the C&C model was built. Lift [25] was used to measure the prediction performance of the model. Lift values in Table 7 show that the prediction rate was improved using the models.

The next step was the application of these models to the remainder of the population, and the prediction of preference retention offers and communication channels to each customer.

After discarding records with missing data, the number of records available were 2247. This 'predict list' was used for target selection.

**Table 7 Lift of C&C model\*\***

	(A)	(B) =(A)/ Total	(C)	(D)= (C)/ (A)	Lift (E)= (D)/ (B)
<b>Retention Offer:</b>					
Handset Subsidies	24	0.18	11	0.46	2.56
Free minutes offer with prepaid	24	0.18	15	0.63	3.49
Free minutes offer without prepaid	78	0.58	73	0.94	1.61
Free mobile internet minutes offer	1	0.01	0	0	0
Special designed gift	7	0.05	2	0.29	5.47
Total	134	1.00			
<b>Communication Channel:</b>					
Email	11	0.09	6	0.55	6.39
DM with monthly invoice	53	0.41	38	0.72	1.75
Short Message	41	0.32	38	0.93	2.92
Personal telephone Contact	24	0.18	12	0.5	2.69
Total	129	1.00			

\*\* 1.(A) : Survey Result  
2.(B) : Occurrence Probability  
3.(C) : Model Predict Result  
4.(D) : Model Hit Rate  
5.(E) : Lift

### 5.3 Target Selection Optimization Model

The GA approach was applied to the optimization problems when:

Y When the amount of budget is undetermined

Y When the amount of budget is determined

Table 8 presents the solutions obtained for an undetermined budget situation. Four alternatives were provided with budgets from 200000 to 500000. Mutation rate was set to 0.15 and the cross over rate to 0.5. The objective function aimed to maximize the customer value score (CVS). The stop criterion was set at the objective value of not improving 0.1% in the last 3000 trials.

The ability of GA to find good solutions within a limited time is shown in Table 8. Resource constraint criteria were set for budget limit, personal phone contact capacity, DM with invoice capacity and minimum geographic customers needed to select. All the optimal solutions according to different budgets are shown in the Table 8. Alternative III generates the highest value per dollar. Managers can modify constraints to meet their specific business needs, and make their optimal decision based on the information suggested.

**Table 8 Alternatives when budget amount is undetermined\*\***

Budget alternatives	I	II	III	VI
CVS	200000	300000	400000	500000
Retention Cost	137249	222259	390056	453986
Value per cost dollar	199421	298674	396426	497524
Time to generate this CVS	0.68824	0.74415	0.98393	0.91249
Numbers of customer selected	461	239	435	918
Retention offer mix	A=32 B=118 C=250 D=0 E=2	A=44 B=165 C=421 D=0 E=4	A=39 B=315 C=681 D=0 E=6	A=64 B=351 C=739 D=0 E=15
Communication-on Channel mix	A=19 B=161 C=43 D=179	A=24 B=248 C=74 D=288	A=35 B=426 C=100 D=480	A=35 B=439 C=135 D=560
Geographic mix	T=106 N=41 C=117 S=104 E=34	T=158 N=53 C=184 S=185 E=54	T=281 N=82 C=287 S=293 E=98	T=296 N=99 C=328 S=332 E=114

- \*\*1. We set constraints: maximum personal phone contact capacity  $\square$  35, DM with invoice capacity  $\square$  500, minimum targets per area  $\square$  20.
2. Initial population is generated by random; population size is set to 200.
3. The objective function is to maximize CVS; an initial random CVS is 100633.
4. We set mutation rate = 0.15, and cross over rate = 0.5.
5. The stop criterion is the objective value without improving 0.1% for the last 3000 trials then stop.
6. The measure unit of time to generate this CVS is second.
7. The measure unit of budget and cost is Taiwan dollar (NT).
8. Retention offer mix: A is handset subsidize, B is Free minutes offer with prepaid, C is Free minutes offer without prepaid, D is Free mobile internet minutes offer, E is special designed gift.
9. Communication Channel mix: A is personal telephone contact, B is DM with invoice, C is email, D is short message.
10. Geographic mix: T is great Taipei area, N is northern area, C is central area, S is southern area, E is eastern area.

Table 9 presents solutions when fixed budget of \$400,000 Taiwan dollars. A better value per dollar (1.004485) was generated in alternative III when the call center capacity constraint was released to 50. The stop criterion for alternatives II and III was not at least a 0.1% improvement over the last 3000 trials. However, a stop criterion was not set for alternative I, and it was stopped manually after a relatively good (optimal) value was generated. A comparison of time taken to reach the optimal CVS values between I and II, a better objective value was achieved as more time were taken, 702 seconds to 1037 seconds. However, more CPU resources are needed to generate the better solution. All the alternatives solutions presented in this table all started from an initial value of 100633 and achieve to the optimal solutions within reasonable time

This is likely to only be a 'good' solution and not necessarily 'optimal'. The mutation rate and cross over rate could have been adjusted to speed up the searching for optimal solution.

**Table 9 The alternatives with the determined budget\*\***

	I	II	III
CVS	392542	390056	399109
Retention cost	399922	396426	397327
Value per cost dollar	0.981546	0.983931	1.004485
Generations to get this value	85.16	46.575	71.37
Time to get this CVS	1309	702	1089
Numbers of customer selected	1037	1041	1073
Communication channel mix	A=35 B=338 C=110 D=504	A=35 B=426 C=100 D=480	A=42 B=403 C=126 D=502

- \*\*1. Communication Channel mix: A is personal telephone contact, B is DM with invoice, C is email, D is short message
2. Capacity constraint of personal telephone contact for alternative I and II is  $\square$  35, for alternative III is  $\square$  50.
3. We set mutation rate = 0.15, and cross over rate = 0.5
4. An initial random CVS is 100633

## 6. Conclusion and Suggestions for Future Research

One of the major implications of target selection in customer retention is its ability to provide marketing decisions information to evaluate different alternatives' impacts on customer equity. In this paper, a methodology for the optimization of target selection based on customer preferences, using a genetic algorithm and where the objective was to maximize customer equity is described.

The study demonstrates the potential of AI technologies for the customer retention process in the mobile industry. This study used a customer needs-based approach to predict the C&C preference of customers, and a different way of applying genetic algorithm to target selection and budget allocation.

While most traditional techniques provide a single best solution, multiple solutions with high performance levels can be advantageous, especially if coupled with a faster solution search time. A genetic algorithms can be useful in such contexts in providing multiple alternatives obtained from independent runs with different random number seeds, crossover rates, mutation rates, or from explicit use of varied fitness criteria. Because genetic algorithms only use an encoding of the solution and its associated fitness value and do not utilize auxiliary information, such as derivatives or assumptions about continuity in the solution process, they can be applied efficiently to a wide range of marketing optimization problems with only minor changes to parts of the algorithm.

One limitation of the current work is the insufficient

data to segment customers due to small scale of sampling in survey and missing data problems in the data warehouse. These problems should be avoided in a formal project implementation. Another important limitation of the work is that it did not empirically investigate the validity of models in real world, taking action on the results of models by carrying out an experiment of treatment group and control group is planned in the future work.

Further empirical investigation is needed to evaluate the effectiveness of the proposed GA method as compared with the traditional methods. Application to retention programs in other industry is needed to demonstrate the broader applicability of this methodology.

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### References

- [1] Directorate General of Telecommunications, Taiwan, *Mobile subscribers statistic report 2001*. www.dgt.gov.tw.
- [2] Reichheld, F. F. Kenny, D. W., "The Hidden advantages of Customer Retention", *Journal of Retail Banking*, 1990, XII(4), 19-23.
- [3] Ahmad, R. Buttle, F., "Customer retention: a potentially potent marketing management strategy", *Journal of Strategic Marketing*, 2001, 9, 29-45.
- [4] Weinstein, A., "Customer-Specific Strategies Customer retention: A usage segmentation and customer value approach", *Journal of targeting, Measurement and analysis for Marketing*, 2002, 10(3), 259-268.
- [5] Admod, A. D., "An Advertising decision Model", *Journal of Marketing Research*, 1975, 12, 37-45.
- [6] Kotler P, A. G., *Principles of marketing*. 7 ed. 1995, New Jersey: Prentice-Hall.
- [7] Berger, P. D. Nasr, N. I., "Customer Lifetime Value: Marketing Models and Applications", *Journal of Interactive Marketing*, 1998, 12(1), 17-30.
- [8] McDougall, G., "Customer Retention Strategies: When Do They Pay Off?" *Services Marketing Quarterly*, 2001, 22(1), 39-55.
- [9] Haley, R. I., "Benefit segmentation: A decision-Oriented research tool", *Journal of marketing*, 1968, 32, 30-35.
- [10] Pelitier, J. W. Schribrowsky, J. A., "The Use of Need-Based Segmentation for Developing Segment-Specific Direct Marketing Strategies", *Journal of Direct Marketing*, 1997, 11(4), 53-62.
- [11] Vriens, M., "Conjoint Experiments for Direct Mail Response Optimization", *European Journal of Marketing*, 1998, 32(3/4), 323.
- [12] Haughton, D. Oulabi, S., "Direct Marketing Modeling with CART and CHAID", *Journal of Direct Marketing*, 1997, 11(4), 42-52.
- [13] ZaHavi, J., "Applying Neural Computing to Target Marketing", *Journal of Direct Marketing*, 1997, 11(1), 5-21.
- [14] Berger, P. D. Nasr, N. I., "The allocation of promotion budget to maximize customer equity", *The International Journal of Management Science*, 2001, 29, 49-61.
- [15] Dhar, V. Stein, R., *Evolving Solutions: Genetic Algorithms*, in *intelligent Decision Support Methods- The Science of Knowledge Work*. 1996, Prentice Hall, International, Inc. 52-76.
- [16] Berry, M. J. A. Linoff, G., *Data Mining Techniques for Marketing, Sales, and Customer Support*. 1997, New York: Wiley Computer Publishing, John Wiley & Sons, Inc.,.
- [17] Abbott, J. & Stone, M., et al., "Integrating customer data into customer relationship management strategy: An empirical study", *Journal of Database Marketing*, 2001, 8(4), 289-300.
- [18] Roberts, M. L. Berger, P. D., *Direct Marketing Management*. 1989, Englewood Cliffs, NJ.: Prentice-Hall.
- [19] Hurley, S. & L.Moutinho, et al., "Solving marketing optimization problems using genetic algorithms", *European Journal of Marketing*, 1995, 29(4), 39-56.
- [20] Bhattacharyya, S., "Direct Marketing Performance Modeling Using Genetic Algorithms", *INFORMS Journal on computing*, 1999, 11(3), 248-257.
- [21] Fazlollahi, B. Vahidov, R., "A Method for generation of Alternatives by Decision Support Systems", *Journal of Management Information Systems*, 2001, 18(2), 229-250.
- [22] Keen, P. G. W. Scott Morton, M. S., *Decision Support Systems: An Organizational Perspective*. 1978, Reading, MA, Addison-Wesley.
- [23] Yang, L. S., *Research Paper, Literature-based Critical Review of Customer Churn Behavior for Mobile Phone Industry in Taiwan, December 2001*, in *International Graduate School of Management*. 2001, University of South Australia: Adelaide, Australia.
- [24] Fayyad, U. & Shapiro, G. P., et al., "The KDD Process for Extraction Useful Knowledge from Volumes of Data", *Communication of the ACM*, 1996, 39(11), 27-34.
- [25] Piatetsky-Shapiro, G. Steingold, S., "Measuring LIFT in Database Marketing", *ACM SIGKDD*, 2000, 2(2), 76-80.

# Strategic Implementation of E-Procurement: A Case Study of an Australian Firm

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## Abstract

The rapid development of Internet technology has made inter-organisation connectivity much easier and cheaper than ever before, hereby providing an opportunity for companies, both large and small, to realise the true value of the Internet. Despite the huge investment and complexity of implementing e-procurement, there is little empirical research to provide managerial guidelines for developing effective procurement strategies and for successfully implementing e-procurement. This paper attempts to fill this gap by reporting an Australian case study on the adoption of e-procurement. The findings offer detailed, varied and practical strategic insights into organisational redesign, critical factors, and challenges. The implications are also offered.

## 1. Introduction

Using e-business to enhance an organization's channel has been considered as a starting point for implementing e-business for many organizations in a business-to-business context [3]. The rapid developments in Internet technology have made the inter-organization connectivity much easier and cheaper than ever before, thereby providing opportunities for many companies, large and small, to real the real value of the Internet.

Implementing e-procurement is of strategic, rather than tactical, importance. It should be regarded as an integrated part of an organization's overall e-business strategy because of its enormous expenditure and potential savings. Many companies spend as much as 30 per cent of their revenue for indirect procurement, that is, non-production materials and services [3, 5]. Traditionally, indirect procurement is a costly pen and paper process that may require more than \$100 dollars just to issue a purchase order. Further, decisions of purchasing many moderated-price goods and services have been at the discretion of individual employees. Finally, as business environment become increasingly competitive, many companies are striving to improve their profitability. Every cent saved in procurement goes straight to the bottom line.

Many organisations, both public or private, are adopting e-procurement programs to reap the benefits of Internet technologies. A recent survey of more than 500 managers in six West European countries by IDC

[4] found that 38 per cent of businesses have used the Internet for procurement.

Despite its huge investment, complex implementation process, and the involvement of multiple functions and departments, little empirical research has been conducted to provide managerial guidelines on developing effective procurement strategies and to successfully implement e-procurement. This paper attempts to fill this gap by presenting a case study of an Australian organization. Specifically, it aims to address the following questions:

- 1) How does it successfully implement e-procurement in order to fully tap the potential of the Internet technology and the emergence of e-marketplace?
- 2) What benefits does the organisation attempt to reap from e-procurement?
- 3) What are the critical factors in implementing e-procurement? and
- 4) What challenges does the organisation face in implementing e-procurement?

## 2. Literature Review

### 2.1 What is E-Procurement

The meaning of procurement is much broader than purchase. Conceptually, it includes such activities as purchasing, transportation, warehousing, and inbound receiving [5].

Functionally, e-procurement can have three approaches: e-procuring non-production goods and services, e-sourcing and e-auction [3]. The non-production goods and services procured are variously known as operating [2], or indirect materials [7]. They can further be broken down into three categories: office and computer supplies, or ORM (Operating Resource Management, mainly office products), maintenance, repairs, and operations (MRO) supplies; and travel and accommodation [5]. MRO is the most important of these three categories one. Because MRO typically includes mission critical overhaul and maintenance, its procurement processes usually involve much higher levels of complexity, cost and volume than ORM and travel and accommodation [7].

Table 1 A Brief Summary of Benefits in Implementing E-Procurement

Studies	Benefits
[3]	Employees compliance with pre-negotiated contracts; Improved leverage with suppliers, and Process improvement
[5]	Efficiency improvement, including: <ul style="list-style-type: none"> <li>ò low procurement costs,</li> <li>ò faster cycle times,</li> <li>ò reduced maverick or unauthorized buying,</li> <li>ò more highly organized information,</li> <li>ò tighter integration of the procurement function with key back-office systems.</li> </ul> Effectiveness enhancement, including <ul style="list-style-type: none"> <li>ò increased control over the supply chain</li> <li>ò proactive management of key procurement data, and</li> <li>ò higher-quality purchasing decisions within organizations</li> </ul>
[2]	Operational benefits: <ul style="list-style-type: none"> <li>ò reducing the administrative costs of the whole procurement process by two third.</li> <li>ò improved expenditure control.</li> </ul> Strategic benefits: <ul style="list-style-type: none"> <li>ò increased procurement control (better coordination between users and purchasers and greater control over sources of supply, purchase price, and inventory policy from adopting a centralized purchasing function),</li> <li>ò better supplier management (reducing supply base and thus increasing leverage over suppliers)</li> </ul>

2.2 Benefits and challenges in implementing e-procurement

Many publications have reported the potential benefits of implementing e-procurement. Some are summarised in Table 1.

The level of saving possible in implementing e-procurement partly depends on the amount of indirect spending that is e-procurable [3]. For example, service is hard to purchase online.

While the benefits to procurers have been well identified and documented, only several publications have reported how suppliers can benefit from e-procurement from a descriptive perspective. By participating in e-supply, suppliers can have several benefits, including sales increase, expansion of market reach, reduction of costs for sales and marketing activities, shorter selling cycle, improved sales productivity, and streamlined bidding process [2, 3, 9].

2.3 Challenges in implementing e-procurement

Given the level of complexity in redesigning procurement processes, integrating multiple functions within the organization, and engaging key suppliers in participating in e-supply, several challenges have been identified and described. In a recent survey of procurement managers in 13 European countries, IDC [4] has reported a number of challenges in implementing e-procurement, including internal

resistance to change (27%), system too difficult to use/understand (11%), e-procurement system integration with existing IT systems (11%), employee training (11%), and supplier migration to the Internet (11%).

Croom [2] reported that management has three major concerns in implementing e-procurement: concern for the management of service supply, such as facilities services, e.g., clearing and catering, particularly with its quality measurement because services are hard to e-procure; concern for security, particularly payment; and concern for supply database maintenance, which may involve a central supply database containing information about process concerns (authority levels for order-placers, supplier details, product/service details), and pricing scheme. The questions are where is this database located and who should be responsible for maintenance.

2.4 The evolution and implementation processes of e-procurement

The development of e-procurement has so far undergone three stages [1]: 1) large companies such as General Motors and Wal-Mart established Internet buying hubs for reducing costs and speeding supply; 2) independent firms created third party exchanges that attempt to bring many buyers and sellers in e-marketplace; and 3) horizontally dominant industry players joined in e-procurement consortiums, such as Covisint in the automobile industry.

With regard to the e-procurement implementation processes, Kalakota & Robinson [5] suggested that a seven-step guideline. These seven steps are to: 1) clarify the company's e-procurement chain goals. Such goals may include automating the selection and purchase of goods, cutting costs, reporting companywide purchasing patterns timely and accurately, or eliminating purchasing by unauthorized employees; 2) conduct a procurement process audit; 3) establish a business case for e-procurement; 4) develop a supplier integration matrix, which helps determine the best type of individual vendor relationship. The type of individual vendor relationship depends on the uniqueness and scarcity of the products or services procured; 5) select an e-procurement application; 6) integrate e-procurement with other applications; and 7) train employees involved.

### 3. Research Methodology

**Research design.** Case study as a research method has been increasingly accepted in social sciences and management studies. Yin [10] has defined case study as "an empirical inquiry that investigate a contemporary phenomenon with its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used" (p. 23). Many e-business applications are still new and not well researched. Therefore, case study is considered to be very appropriate for this stage of e-business application development.

**Case selection.** Many companies use e-procurement based on Internet technologies as a strategy to improve competitive advantages. Therefore, it is expected that the decision to adopt e-procurement is made at head office given the quantity of money invested and the number of functions and departments involved. Moreover, the potential significant benefits that can be reaped from implementing e-procurement often dictate that large manufacturing firms are more likely at the forefront of companies rushing to exploit e-procurement. Thus, these companies tend to be large and in manufacturing sector, and they are targeted for this study.

Woodside, a large Australian oil and gas exploration company, has some characteristics that apply to an e-procurement study. First, Woodside has learnt much from Shell, its significant shareholder and an early adopter, in implementing e-procurement through their close relationship. Therefore, what Woodside has done in implementing e-procurement could be more solid than that of early adopters. This means it can offer a good pathway to e-procurement for other companies.

Second, Woodside is a major player in the Australian oil and gas industry. It not only can exercise considerable power in engaging suppliers in e-supply,

which is crucial to the success of e-procurement, but also is able to initiate other e-procurement programs, such as e-sourcing and e-auction, for its industry. Hence, this case study can also shed light on how e-procurement impact on the firms involved and the whole industry.

Finally, Woodside not only has large procurement expenditure (about A\$1.3 billion annually) and many supply chains, but also has many geographically dispersed plants and groups. This requires effort in coordinating a range of activities other than mere procurement, such as transportation, warehousing and inbound receiving. All these can provide a large and complete picture about e-procurement at the organizational level.

**Data collection and analysis.** Multiple sources were used to collect data, including interview with two senior procurement managers, compilation of information from the company's Web site and media reports, and collection of the materials and booklet about e-procurement at Woodside and Shell during the interview. The interview was conducted at Woodside headquarters in Perth using a semi-structured approach. Specifically, a list of questions was prepared based on literature review. These questions covered four major areas: the implementation processes, benefits and challenges, integration of e-business applications and other IT-related issues, and critical factors. However, we also kept an open mind during the interview to ensure that other important issues would be captured. The "funneling approach", as suggested by Minichiello et al [6], was used. The interview lasted about two and half hours and was tape-recorded. The recorded tape was then transcribed. Although several computer software packages, such as NUDIST or Nvivo, developed by Qualitative Solutions and Research Pty Ltd [8] could be used to facilitate qualitative data analysis, we have decided to analyse the data manually for two reasons. First, most of these software packages for qualitative data analysis require much time and effort to set up the project. Second, this research only involved one case.

The information and materials collected from the company's Web site, promotional materials, and media reports were used to further complement or triangulate the findings from the interview.

### 4. Background Information of the Company

Based on Perth, Woodside Energy is a leading Australian resources company. Its main business is in the exploration, development, and production of hydrocarbon products, such as oil and natural gas.

Woodside was founded in 1954 to search for oil. Its major expansion came in 1963 when it secured exploration permits over 367,000 square kilometres off

the Western Australian coast. In the early 1970s, it successfully discovered the several gas fields in Western Australia's harsh Pilbara region. These fields were eventually to form the basis of Australia's biggest energy resource development: the North West Shelf Venture, which is the biggest and one of the most important natural resource developments ever undertaken in Australia.

Delivery of North West Shelf natural gas to customers in Western Australia (WA) began in 1984. With deregulation of the domestic gas market in WA, it now sells directly to major energy consumers in WA.

Another Woodside product is condensate, a light oil produced in association with gas. The first crude oil development was produced in the late 1980s. Production from the Floating Production, Storage and Offtake facility (FPSO) began in 1995. The following month it also began exporting Liquefied Petroleum Gas (LPG). In late 1999, under Woodside's operatorship, the Northern Endeavour FPSO began producing oil in the Timor Sea. This was its first operations outside the North West Shelf Venture.

Woodside is also actively exploring for oil and gas in WA, Victoria, the Timor Sea, and several overseas sites. In 1999, Woodside has implemented ERP developed by a Tier One ERP developer.

In 2001, Woodside production included 7.2 million barrels of crude oil and 1.25 tons of liquefied natural gas. It employed about 2500 people and generated annual revenue of A\$2.34 billion. The annual procurement expenditure is about A\$ 1.3 billion. There were approximately 9000 procurement invoices to process per month.

## 5. Implementing E-procurement at Woodside

### 5.1 Redesign organizational structure based on the product and service market

The e-procurement program was initiated on 1<sup>st</sup> April 2000. As the first step, a new division, Shared Services, was established based on a detailed analysis of the goods and services it procures, its procurement spending, and existing procurement processes. The two guiding principles used for this organizational restructuring are market of goods and services procured, and e-procurement process. This division now covers most important functions and activities involved in the procurement processes. It employs 90 people and consists of nine teams or groups.

The first team, Business Development, is responsible for research and development in procurement. Its specific tasks include redesigning the e-procurement processes, monitoring new development,

and planning the directions for e-procurement. Another important task for this team is to communicate with suppliers and to get them involved in e-supply.

The second team is Communication and IT. It controls expenditure in telecommunications and other IT related areas, such as the purchase of software and hardware, and license and contract management in IT areas. The company has 1500 personal computers. So its expenditure in communication and IT is very substantial.

Another team is Contracts and Services. Its responsibilities cover legal, insurance, financial, and logistic issues in dealing with suppliers. This team manages all the contracts and services required to sustain other parts of the Shared Services division.

The next group is Plant that is physically located in a natural gas treatment plant that is about 1,300 kilometres away from Perth. This is essentially a virtual team. The team's tasks include the procurement of MRO for the plant, management of a warehouse, and logistics and inventory management.

Topsides is another team. It provides all of the support in procuring goods and services for the company's entire offshore asset, mainly the platforms and the Floating Production and Storage Offload Facility (FPSOs). These goods and services include a maintenance contract, paints, and any spare parts for rotating equipment and inventory management.

Procurement Support Group deals with two major functions: Account Payable Management and Cataloguing. Accounts Payable was part of the company's finance organization before implementing e-procurement. When the e-procurement management team mapped out the supply chain, they suddenly realised that accounts payable is the back end of its supply chain because any relationships associated with vendors and contractors can be impacted by the lack of payment of their invoices. Therefore, Accounts Payable was included in the Shared Services division. According to the interviewees, this has so far worked very well because it facilitates the communication between account payable and procurement. The Catalogue team is mainly responsible for maintaining and updating the catalogue centrally. It also requires some research effort to ensure that the new items added will fit the technical specifications and safety requirements. There are now about 8000 line items in the company's catalogue. Another important task for Cataloguing team is to search for Original Equipment Manufacturers (OEM) in purchasing MRO to cut off the middlemen, or dis- intermediate channels, in order to drive the costs down.

The Drilling team (exploration), as its name indicates, is the team that supports the well engineering

part of the company's businesses. Drill has to be made through the sea-bed in order to find gas or oil. The goods this team procures include drill bits, casting, modules, all the chemicals associated with drilling, and the mobile drilling rigs that are used to charter in to initiate the drilling.

The last group within Shared Services division is sub-sea and exploration group. In order for the company to initiate drilling, a 3D or 2D seismic survey of the sea-bed need to be conducted to determine whether the geographic strata of the sea-bed lends itself to a drilling program. The Group manages all MRO for all sub-surface needs, including all chartering seismic vessels, and the sub-sea components.

## 5.2 Intended benefits for implementing e-procurement

After conducting business analyses, Woodside considers that it can benefit from implementing e-procurement in the following five ways:

Capturing and reducing rogue spending. By 'rogue spending', it means that those spending is outside of its procurement contracts. As the manager of the Shared Services Division pointed out that there are many people, particularly when they weren't associated with a central group, were actually spending money outside of contracts. This problem has been addressed by implementing e-procurement.

Better analysis, better spending tracking, and better contracting prices. The implementation of e-procurement can facilitate the collection and analysis of spending data. This can ensure better tracking of procurement spending. Thus, company can consolidate spending and leverage such aggregated purchase volume to get a better deal from the suppliers. This can enable the company to have more robust contracts. Therefore, the bottom line of the company can be improved by extracting much overheads out of its procured goods and services through e-procurement.

Cutting out distributors to drive down prices. Another benefit the company expects from implementing e-procurement is to lower the prices of goods purchased by cutting out some of its distributors and the middle men. E-procurement provides opportunities for the company to go straight to the source of manufacture. Currently, it is unable to do that and many of the suppliers force it to go through an agent who typically "puts on his 10% or his 15%". Because e-procurement doesn't recognise any international boundaries, it enables the company to go right back to the source of the manufacturer and to negotiate better prices by cutting out some of the middle people

Optimising logistics to reduce transportation costs. Before implementing e-procurement, the company was able to rely upon a network that funnelled everything through to its distribution depot. Because of implementation of e-procurement, a layer of middlemen or distributor has been taken out. Hence its distribution channel could become wider. This seems to create challenges for the company to coordinate its procurement activities. However, the logistics aggregation can be made within the terms and conditions of the purchase order that e-procurement can send out electronically. Although the logistic carriers the company used would still be the same and the method of delivery or transportation would not be changed, the company could simply optimise it. This could leverage the movement of the materials purchased and thus reduce the logistics costs.

Logistics costs can also be further reduced by collaborating with other companies, particularly those that have branches located in the same remote areas. For example, Woodside has developed some sharing agreements with BHP, another Australian major player in oil and mineral industry. Because both companies work in the same industry and need to transport goods procured to the same remote areas, aggregating materials procured for transportation can make Woodside to get an economy of scale. The implementation of e-procurement can make such inter-firm collaboration much easier, particularly with the recent establishment of the online industry's supplier database, Supplybase Vendor Registration System ([www.supplybase.com.au](http://www.supplybase.com.au)), where Woodside is a major player.

Facilitating advanced planning for maintenance by integrating e-procurement with ERP and other e-business applications. With the installation of ERP and PM (preventive maintenance) within the company, the installation of e-procurement software EBP (Enterprise Buyer Professional) can enable the company to undertake advanced planning and maintenance. With the plant maintenance module, it can plan plant maintenance and shutdown anywhere up to 7 years in advance. The integration of e-procurement with ERP and PM enables the company to automatically place the orders and generate requests on suppliers or vendors for the goods and parts, particularly critical items. One advantage for having one integrated system is in the plant maintenance. The system can facilitate planning, calculate the lead-time, and flag the critical items for maintenance.

### 5.3 Critical factors in implementing e-procurement

Having implementing e-procurement for nearly two years, Woodside has identified some critical factors as follows.

1. Ensuring e-procurement is compatible with the back end ERP system, including the maintenance system. Woodside is a manufacturing firm and the maintenance of its operation and exploration is critical to its success. Therefore, it is crucial that the e-procurement package should be compatible and complementary to its ERP system.
2. The second critical factor, as the interviewee stressed, is good preparation and active monitoring and learning. As he stated that “you should allow yourself plenty of time and to move around the world and see how it is going in other parts of the world. So that you can bring in the lessons learnt.” This is very important, particularly in selecting the software for e-procurement.
3. Undertaking a good detailed analysis of procurement spending is another critical factor. It is not good jumping on the e-procurement bandwagon if it is not going to deliver the benefits. Only after a detailed spend analysis, can the benefits of implementing e-procurement be determined.
4. Communicating both internally and externally is also a critical factor for successfully implementing e-procurement. Also, competent people are needed who can implement the process.
5. The last, but not least, critical factor is to adopt a gradual approach. Start small and then make big. Because implementing e-procurement is a complex process, such a gradual implementation process can ensure that project can be properly controlled and lesson can be learned quickly. At the beginning, it is better to involve four or five key suppliers in e-supply.

### 5.4 Challenges in implementing e-procurement

Several challenges have been also identified in implementing e-procurement at Woodside, including issues in human resource management, technology integration, and supplier's involvement.

One challenge in implementing e-procurement is the redeployment and training of employees. Because e-procurement can automate significantly many processes, some existing employees have to be redeployed. Also the skills required for its employees need to be changed, specifically, from putting together purchase orders to putting procurement deals together. This shift in skill

requirements demands employees equip with more negotiation skills.

Revamping IT system and integrating IT with other applications, such as ERP, and Preventive Maintenance are also challenges the company face. The compatibility, or interoperability, of various e-business applications is a problem for the company. Although the company purchased all the software (ERP, PM, EBP) from the same software developer, they were not compatible in data communication in their standalone package. The software developer has been working for solving this problem. Nevertheless, it had presented as a stumbling block and the project had to be delayed until EBP is installed and tested.

Finally, how to involve its suppliers in e-supply is another challenge. The manager is cognizant of this issue and intends to adopt a staged approach to engaging suppliers in this area. Several large hardware suppliers who the company has already dealt with in e-procurement in other parts of Australia would be selected first. Then each quarter the number of suppliers will be increased until it has achieved what it believes the critical mass in terms of its high-volume and low value spend.

## 6. Summary and Implications

This paper attempts to explore several important issues in implementing e-procurement. To do so, a case study on the e-procurement implementation practice in an Australian organization was conducted. This has shed much light into several strategic issues and provided guidelines for other firms that wish to implement e-procurement in their own organizations. Several important results have been presented in this paper and can be briefly summarized as follows.

First, implementing e-procurement may need to redesign organization. Such organizational restructure should be based on the e-procurement processes. It also needs to ensure avoiding the overlapping of functions. The overall objectives are to simplify the e-procurement process and to provide “total” services both to the organization itself and the suppliers involved. In doing so, Woodside has established a new division, Shared Services that includes all important functions in procurement. The division itself has been structured based on the market of goods and services procured.

There are four areas that the company can potentially reap the benefits in implementing e-procurement. They are: 1) making employees comply with the prenegotiated contracts to improve procurement effectiveness; 2) leveraging the consolidated spend data to get better prices from suppliers; 3) dis-intermediating distribution channels to cut out middlemen, thereby lowering the prices of goods purchased; and 4) collaborating with other

players in aggregating goods procured to drive down logistics costs.

Like other e-business application, implementing e-procurement entails challenges. For Woodside, it faced three challenges: employee redeployment and training, integration of e-procurement with other e-business applications, and supplier involvement.

Finally, conducting a detailed business case analysis of procurement spending, well preparation, gradual implementation, and internal and external dialogue can pay off in implementing e-procurement.

The above findings have a number of important implications for managers. First, implementing e-procurement is very complex and can involve many functions and departments within the company, such as IT, HR, Finance, and Legal Services. Therefore, securing commitment from top management can be very important for successfully implementing e-procurement.

The second implication is that compatibility of various e-business applications should be considered thoroughly. It is a strategic issue given the amount of investment in these applications. Many firms may want to adopt a staged approach in implementing e-business applications. However, a critical question to ask in selecting a software package is: Can it inter-operate with other e-business applications that are potentially adopted by our organization in the future?

The findings in this paper also imply that e-procurement should be considered in a broad sense in order to fully tap its potentials. E-procurement involves much more functions than simply purchasing, including warehousing and transportation. Thus, in conducting business case analysis for e-procurement and redesigning organization structure, activities and benefits or costs incurred from these functions should be considered for streamlining e-procurement processes and generate a more 'realistic picture' about the consequences or outcomes of e-procurement.

## References

- [1] Ageshin, E.A., E-Procurement at work: A case study. *Production and Inventory Management Journal*, 2001(First Quarter): p. 48-53.
- [2] Croom, S.R., The Impact of Web-Based Procurement on the Management of Operating Resources Supply. *The Journal of Supply Chain Management*, 2000(Winter): p. 4-13.
- [3] Deise, M.V., et al., *Executive Guide to E-Business: From Tactics to Strategy*. 2000, New York: John Wiley & Sons, Inc.
- [4] International Data Corporation, *European Procurement Managers Move to Internet*. 2001, IDC.
- [5] Kalakota, R. and M. Robinson, *e-Business: Roadmap for Success*. 1999, Sydney: Addison Wesley Longman, Inc.
- [6] Minichiello, V., et al., *In-Depth Interviewing: Research People*. 1992, Melbourne: Longman Cheshire Pty Limited. 1-357.
- [7] Neef, D., *e-Procurement: From Strategy to Implementation*. 2001, NJ: Prentice Hall PTR.
- [8] Qualitative Solutions and Research Pty Ltd, *Non-numerical Unstructured Data Indexing Searching and Theorizing*. 1997, Qualitative Solutions and Research Pty Ltd: Melbourne.
- [9] Turban, E., et al., *Electronic Commerce: A Managerial Perspective*. 2000: Prentice Hall International, Inc.
- [10] Yin, R., *Case Study Research*. 2nd ed. 1994, London: Sage Publication.

# Performance Evaluation for 59 Listed Electronic Corporations in Taiwan

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## Abstract

Most previous studies concerning company performance evaluation focus merely on operational efficiency. Operational effectiveness, however, which might directly influence the survival of a company is usually ignored. As a result, this paper presents a study which uses an innovative two-stage data envelopment analysis (DEA) model that separates efficiency and effectiveness to evaluate the performance of 59 Listed corporations of the electronics industry in Taiwan. The empirical result of this paper is that a company with better efficiency doesn't always mean that it has better effectiveness. There is no apparent correlation between these two indicators.

Key Words: Performance Evaluation; Data Envelopment Analysis (DEA); Electronic Industry

## 1. Introduction

Data envelopment analysis (DEA) is a mathematical programming approach for characterizing the relationships among multiple inputs and multiple outputs. There is a wealth of literature on both basic and applied research in DEA. Since the DEA model was proposed by Charnes, Cooper, and Rhodes in 1978[3], it has been widely used in non-profit organizations. Since then, numerous applications have appeared in profit organizations, such as the banking industry (see [21] [17] [6]), securities (see [12]), insurance (see [13]), medical services (see [10]), real estate brokerage (see [4]), construction (see [5]), the mutual fund industry (see [22] [14]), the airline industry (see [11] [18]) and so on. But, most previous studies concerning company performance evaluation focus merely on operational efficiency. Operational effectiveness, however, which might directly influence the survival of a company is usually ignored. As a result, the paper attempts to evaluate the company performance in terms of efficiency and effectiveness.

This purpose of the paper is to construct a conceptual framework, based on the return on assets, a ratio commonly discussed in financial analysis, to define the meanings of performance. Besides, the paper uses a recently developing model of data envelopment analysis

proposed by Cooper, Seiford and Tone in 2000 [7].

The remainder of the paper is organized as follows. Section 2 defines the meanings of efficiency, effectiveness and performance and its evaluation process. Section 3 describes the DEA methodology. Finally, a case study is conducted using the example of Taiwan's 59 listed corporations of electronics industry.

## 2. Evaluation Process

### 2.1 The Meanings of "Efficiency", "Effectiveness" and Performance"

Most scholars define performance as the degree of achievement towards the set goal. However, some suggest differently. The following are some suggestions on the meaning of performance from a variety of literature:

- (1). Management guru Peter Drucker (1963) [9] uses efficiency and effectiveness in analyzing performance, defining efficiency as "doing things right" and effectiveness as "doing the right thing". If a manager maximizes the output for a given level of input, we could say that he has achieved efficiency. On the other hand, we could say that he achieves no efficiency. Effectiveness refers to the degree of achieving the set goal of the organization. In order to avoid "doing the right things using the right method or the wrong method", enterprises need to distinguish between effectiveness and efficiency. In principle, effectiveness should be set as the primary goal, from which efficiency is enhanced.
- (2). Venkatraman and Ramanujam (1986) [23] look into the issue from the perspective of strategic management. They suggest that business performance is a part of organizational effectiveness, and proposed three levels of performance evaluation, namely: (i) financial performance; (ii) financial + operational performance; and

- (iii) organizational performance.
- (3). Sailaggyi, A. D. (1984)[20] holds that performance evaluation is a global concept, representing the result of organizational activities.
  - (4). Traditionally performance measures have been seen as a means of quantifying the efficiency and effectiveness of action [15].
  - (5). Nanni et al. (1990) [16] use the analogy of a thermostat to explain how performance measures are part of a feedback loop, which control operations against a specific value.
  - (6). Berliner and Brimson (1988) [2] state that performance evaluation is a key factor in ensuring the successful implementation of a company's strategy.
  - (7). Appropriate performance measures are those which enable organizations to direct their actions towards achieving their strategic objectives [8].

The above summary of literature indicates that different researchers define performance differently, depending on the focus of their study. However, there is also inconsistency in the use of the terms "efficiency", "effectiveness" and "performance". For the purpose of allowing readers to distinguish the meanings of the three terms, the author explains the distinction of the three in terms of Return on Assets, a topic commonly discussed in financial analysis:

$$\text{Return on Assets (Performance)} = \frac{\text{Earning Before Taxation}}{\text{Total Assets}}$$

(This can be broken down into 2 equations)

$$= \frac{\text{Earning Before Taxation}}{\text{Net Sales}} \times \frac{\text{Net Sales}}{\text{Total Assets}}$$

$$= \frac{\text{Profit Ratio (Effectiveness)}}{\text{Total Assets Turnover (Efficiency)}} \times$$

Return on Assets (Performance): It assesses the profitability of total assets before taxation, and could be treated as performance in this study. It contains two elements, efficiency and effectiveness.

Profit ratio (Effectiveness): It assesses the net profitability before taxation during the current accounting period. It could be treated as the element of effectiveness in this study and is defined as the ability to achieve the expected goal (result or output).

Total Assets Turnover (efficiency): It assesses the ability of the firm to use its assets and it could be treated as efficiency in this study. It is defined as the output generated by given resources under the influence of the environmental factors.

$$\text{Performance} = \text{Effectiveness} \times \text{Efficiency}$$

The above analysis shows that performance is indeed the product of multiplying efficiency by effectiveness.

## 2.2 A Two-Stage Evaluation Process

Based on the above definition of performance, this paper evaluates the performance of Taiwan's 59 listed corporations of electronics industry via a two-stage evaluation process that separates efficiency and effectiveness.

Figure 1 is an introduction of a two-stage evaluation process. The process is divided into two stages and the six factors are expressed as inputs and outputs at each stage. The first stage (Stage 1) measures efficiency, i.e., a company's ability to generate the sales in terms of its capital, asset, and employee. The second stage (Stage 2) measures effectiveness, i.e., a company's profit and operating revenues by the sales it generates.

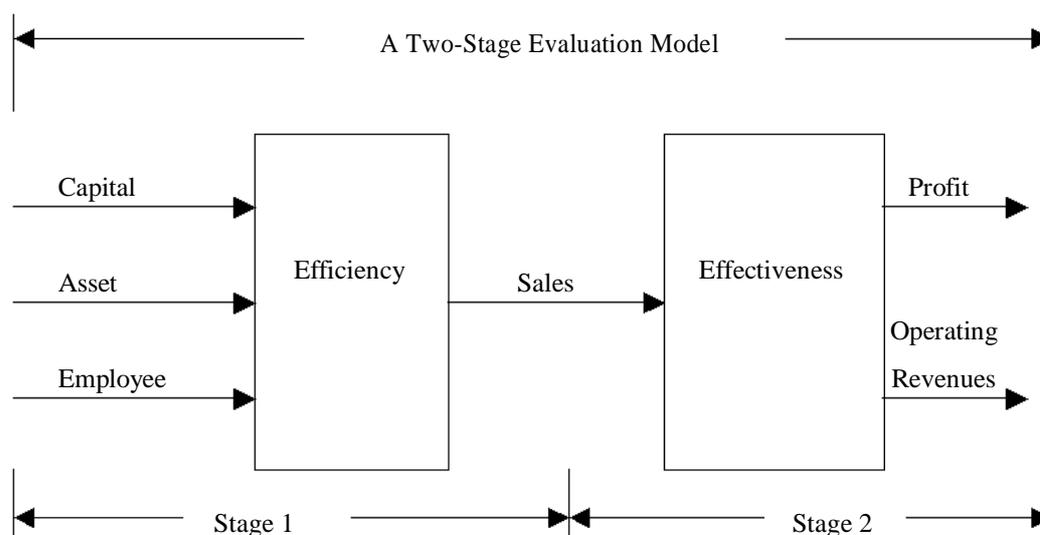


Figure1: A Two-Stage Evaluation Model

### 3. Methodology

DEA, a mathematical programming approach for characterizing the relationships among multiple inputs and multiple outputs, has proven itself as a metric for measuring company performance. The concept of Pareto Optimality in economics is used to measure efficiency, and is the core of DEA. This method was proposed by Charnes, Cooper and Rhodes in 1978. Based on the concept of envelopment in economics, the three projected the input and output of all units subject to evaluation (Decision Making Unit, DMU) on a geometric map to find the limits. If both the input and the output fall above the efficiency margin, then the DMU is efficient. Likewise, if the input and output fall within the efficiency margin, then the DMU is inefficient. The basic idea of DEA is to identify the most efficient DMU among all DMUs. The most efficient DMU is called a Pareto-optimal unit and is considered the standard for comparison for all other DMUs. The Pareto-optimal unit is the one such that any change that makes some people better off makes other worse off.

The most widely used models for DEA are the CCR and the BCC. The former was proposed by Charnes, Cooper and Rhode in 1978 based on the concept of “two inputs and one output” originally spelled out by Farrell in 1957. The three scholars have modified the concept to “multiple inputs and multiple outputs” in order to meet the needs of the complex production procedure of today. The fundamental premise is that under fixed scale of return is used to measure the overall technological efficiency of DMU. The latter was proposed by Banker, Charnes and Cooper in 1994, with the purpose of extending the concept of the CCR model and scope of application. The fundamental premise of the latter is that where scale of return is changeable, the overall technical efficiency of the CCR model could be compartmentalized into pure technical efficiency and scale efficiency.

In this study, the author will use the revised CCR model proposed by Cooper, Seiford and Tone in 2000 to evaluate the performance of Taiwan’s 59 listed corporations of electronics industry. The model is demonstrated below:

Assuming that there are  $n$  decision units and each  $DMU_j$  uses  $m$  input  $X_i$  to produce  $S$  output  $Y_r$ , we find the CCR model from the following equation if the scale of return is constant:

$$\text{s.t. } X_{io} = S + \sum_{j=1}^n X_{ij} \lambda_j$$

$$\Phi_0^t Y_{ro} = -S_r^+ + \sum_{j=1}^n Y_{rj} \lambda_j$$

$$\lambda_j, S_r^+, S_i^- \geq 0 \text{ for all } j, r, i$$

$$r=1, \dots, s$$

$$i=1, \dots, m$$

$$j=1, \dots, n$$

$$t=1 \text{ is stage 1; } t=2 \text{ is stage 2}$$

$$X_{ij} \text{ is the } i\text{th input of the } j\text{th DMU}$$

$$Y_{rj} \text{ is the } r\text{th output of the } j\text{th DMU}$$

$$S^- \text{ is the difference input variable}$$

$$S^+ \text{ is the difference output variable}$$

$$\lambda_j \text{ is the } j\text{th DMU weight value}$$

$$\epsilon \text{ is the Archimedes value, usually set as } 10E-4 \text{ or } 10E-6$$

In Stage 1, we have  $n = 59$  DMUs (corporations);  $i = 3$  inputs: capital, asset, and employee; and  $r = 1$  outputs: sales.

In Stage 2, we have  $n=59$  (corporations);  $i = 1$  inputs: sales; and  $r = 2$  outputs: profit and operating revenues.

## 4. Case Study

### 4.1 Data and Sample

59 listed Corporations of electronics industry in the Taiwan Stock Exchange Corporation (TSEC) for Year 1999 will be measured. All input and output data of these companies are obtained from Taiwan Stock Exchange Corporations (as shown in Appendix 1).

### 4.2 The Software for Calculating DEA Efficiency Value

The data from all DMU in this study is subject to the calculation of the Frontier Analyst software based on the revised CCR model in order to obtain the DEA efficiency value. If the DEA efficiency value is equal to 1, it means it is the best efficiency and hence the unit is the most efficient unit.

### 4.3 The Correlation Coefficient Between the Input and Output Variables

The Pearson Product Moment Correlation Coefficients of all input and output variables calculated by the Frontier Analyst software are shown in Table 1 and Table 2. From the both tables, we find out that all input and output variables chosen for this study are strongly correlated.

$$\max \Phi_0^t + \epsilon \left( \sum_{i=1}^m S_i^- + \sum_{r=1}^s S_r^+ \right) \quad t = 1, 2 \quad (1)$$

Table 1 The Pearson Product Moment Correlation Coefficients of All Input and Output Variables of the Stage 1 Efficiency Model.

Input Output	Capital	Asset	Employee
Sales	0.96	0.99	0.98

Table 2 The Pearson Product Moment Correlation Coefficients of All Input and Output Variables of the Stage 2 Effectiveness Model.

Output Input	Profit	Operating Revenues
Sales	0.91	0.95

#### 4.4 The Evaluation Result of 59 Listed Corporations

Table 3 report the CCR efficiency scores, only nine corporations, namely POTRANS (2378)<sup>1</sup>, EMC (2383), AVISION (2380), Q-RUN (2354), ACER (2353), HON HAI (2317), SYNEX (2347), QCI (2382) and ACER (2306), are CCR-efficient in the stage 1 efficiency model. Five corporations, namely, TMC (2338), POE (2370), ABILITY (2374), RITEK (2349) and TSMC (2330), are CCR-efficient in the stage 2 effectiveness model. Table 3 also reports the total performance scores of the two models and the rank of 59 listed electronic corporations. The top 5 performing companies are as follows. AVISION (2383) (score = 71.42%) ranks first, next is TSMC (2330) (score = 57.03%), ABILITY (2374) (score = 54.67%) is third, ASUSTEK (2357) (score = 46.95%) is fourth, QCI (2382) (score = 34.66%) is fifth.

Note the relation between both models (efficiency and effectiveness). In our case, within 59 Listed corporations of electronics industry, the company with best efficiency doesn't always mean having best effectiveness. For example, TMC (2338) ranks first in effectiveness but ranks last second in efficiency. There is no apparent correlation between these two indicators. Further, from the efficiency distribution of 59 corporations, we find that only 15.25% (9/59 DMUs) of the companies were efficient for the stage 1 and 8.47% (5/59 DMUs) of the companies were efficient for the stage 2.

#### 4.5 Process Improvement

The analysis of the previous section indicated which electronic companies were efficient and which are inefficient. For each stage, inefficient electronic companies are able to improve their performance and the DEA projections provide a prescription for improvement. For example, 2383(EMC) was CCR-efficient in stage 2 effectiveness model; however, it can move its performance to best-practice by either (1) increasing its profits and operating revenues, or (2) decreasing its sales. Thus, inefficient electronic companies are able to improve the overall performance via the stage 1 or the stage 2.

#### 4.6 The Relation between Efficiency and Effectiveness

The author employs the business strategy matrix derived by Boston Consulting Group (BCG matrix) to illustrate the individual evidence in the relationship between efficiency and effectiveness (see Table 4). It has been observed that 4 (EMC, TSMC, ABILITY and ASUSTEK) of 59 companies are in the "super star" group which is characterized by high efficiency and high effectiveness. Conversely, 25 (BTC, FIC, SOLOMON, TECOM, PICVUE, SILITEK, ASKEY, DELTA, LITE-ON, Q-RUN, TATUNG, AURORA, LPI, BENQ, MTI, WUS, COMPEQ MFG, YAGEO, MXIC, GCE, CHIN-POON, D-LINK, RECTRON, MIC) of 59 companies are characterized by low efficiency and low effectiveness and placed in the "problem child" group. The author can argue that the 25 problem child companies should rearrange input to improve their performance.

<sup>1</sup> The numbers stand for the stock-number code of the company in Taiwan Stock Exchange Corporation (TSEC).

## 5. Conclusions

This paper uses a recently developing model of data envelopment analysis proposed by Cooper, Seiford and Tone in 2000 to evaluate the performance of 59 Listed corporations of the electronics industry in Taiwan. The estimated results show that for the stage 1 efficiency model only nine corporations, namely, POTRANS (2378), EMC (2383), AVISION (2380), Q-RUN (2354), ACER (2353), HON HAI (2317), SYNEX (2347), QCI (2382) and ACER (2306), are efficient, and for the stage 2 effectiveness model only five corporations, namely, TMC (2338), POE (2370), ABILITY (2374), RITEK (2349) and TSMC (2330), are efficient. The inefficient companies can effectively promote resource utilization efficiency by better handling their labour and capital operating efficiency. The result also indicates that the corporation with better efficiency doesn't always mean that it has better effectiveness. There is no apparent correlation between these two indicators.

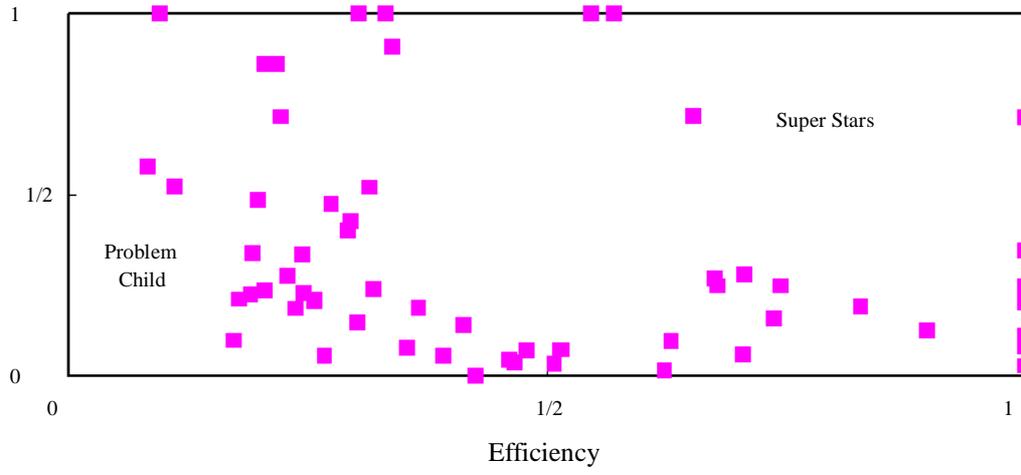
## References

- [1] Banker, R. D., A. Charnes and W. W. Cooper, "Model for the Estimation of Technical and Scale Efficiencies in Data Envelopment Analysis," *Management Science*, 1984, 30, 1078-1092.
- [2] Berliner, C. and J. A. Brimson (Eds), *Cost Management for Today's Advanced Manufacturing*, New York: Harvard Business School Press, 1988.
- [3] Charnes, A., W. W. Cooper and E. Rhodes, "Measuring the Efficiency of Decision Making Units," *European Journal of Operational Research*, 1978, 2(6), 429-444.
- [4] Chang, Chia-Chin, To Apply DEA Method to Evaluate Performance for Real Estate Industry, Unpublished Master Thesis, Department of Business, Chung Yuan Christian University, 2000.
- [5] Chen, Chiao-Wen, To Build Up a Model for the Evaluation of Financial Performance of the Construction Firm, Unpublished Master Thesis, Department of Civil, National Central University, 2000.
- [6] Chen, Tser-Yieth and Tsai-Lien Yeh, "A Study of Efficiency Evaluation in Taiwan's Banks," *International Journal of Service Industry Management*, 1998, 9(5), 1-8.
- [7] Cooper, William W., Lawrence M. Seiford and Kaoru Tone, *Data Envelopment Analysis: A Comprehensive Text with Models, Applications, References and DEA-Solver Software*, Boston: Kluwer Academic Publishers, 2000.
- [8] Dixon, J.R., Nanni, A.J. and T.E. Vollmann, *The New Performance Challenge: Measuring Operations for World-Class Competition*, Homewood: Business One Irwin, 1990.
- [9] Drucker, Peter F., *Peter Drucker On the Profession of Management*, Chinese Edition, Taipei: Commonwealth Publishing Co. Ltd, 1963.
- [10] Grosskopf, S. and V. Valdmanis, "Measuring Hospital Performance: A Nonparametric Approach," *Journal of Health Economics*, 1987, 6, 89-107.
- [11] Huang, Chung-Hsing and Lan-Kuai Huang, "A DEA Application to Route Operational Effectiveness of Airlines," *Journal of Management*, 2000, 17(1), 149-181.
- [12] Lin, Chi-Huang, "A Study of Efficiency Evaluation in Taiwan's Securities Dealers," *Securities Finance Quarterly*, 1998, 58, 1-24.
- [13] Mahajan, J., "A Data Envelopment Analytic Model for Assessing the Relative Efficiency of the Selling Function," *European Journal of Operational Research*, 1991, 53(2), 189-205.
- [14] McMullen, P. R. and R.A. Strong, "Selection of Mutual Funds Using Data Envelopment Analysis," *Journal of Business and Economic Studies*, 1998, 1, 1-12.
- [15] Neely, A., M. Gregory and K. Platts, "Realizing Strategy Through Measurement," *International Journal of Operation and Production Management*, 1995, 14(3), 140-152.
- [16] Nanni, A.J., J.R. Dixon and T.E. Vollmann, "Strategic Control and Performance Measurement- Balancing Financial and Non-Financial Measures of Performance," *Journal of Cost Management*, 1990, 4(2), 33-42.
- [17] Oral, M. and R. Yolalan, "An Empirical Study on Measuring Operating Efficiency and Profitability of Bank Branches," *European Journal of Operational Research*, 1990, 46, 3, 282-294.
- [18] Schefczyk, M., "Operational Performance of Airlines: An Extension of Traditional Measurement Paradigms," *Strategic Management Journal*, 1993, 14(4), 301-317.
- [19] Sengupta, Jati K., "Comparing Dynamic Efficiency Using a Two-Stage Model," *Applied Economic Letters*, 2000, 7(8), 521-525.
- [20] Sailagyi, A. D., *Management and Performance*, Section Edition, 1984.
- [21] Sherman, H. D. and F. Gold, "Bank Branch Operating Efficiency: Evaluation with Data Envelopment Analysis," *Journal of Banking and Finance*, 1985, 9, 297-315.
- [22] Tarim, S. Armagan and Mehmet B. Karan, "Investment Fund Performance Measurement Using Weight-Restricted Data Envelopment Analysis," *Russian and East European Finance and Trade*, 2001, 37(5), 64-84.
- [23] Venkatraman, N. and V. Ramanujam, "Measurement of Business Performance in Strategy Research: A Comparison of Approaches," *Academy of Management Review*, 1986, 11(4), 801-814.

Table 3 Efficiency Results

Company	Code	Stage 1: Efficiency	Stage 2: Effectiveness	Total Performance	Rank	Company	Code	Stage 1: Efficiency	Stage 2: Effectiveness	Total Performance	Rank
EMC	2383	100.00%	71.42%	71.42%	1	SPIL	2325	24.42%	33.34%	8.14%	31
TSMC	2330	57.03%	100.00%	57.03%	2	SYSTEX	2343	31.90%	23.98%	7.65%	32
ABILITY	2374	54.67%	100.00%	54.67%	3	ACCTON	2345	36.61%	18.90%	6.92%	33
ASUSTEK	2357	65.37%	71.82%	46.95%	4	OPTO	2340	19.25%	33.72%	6.49%	34
QCI	2382	100.00%	34.66%	34.66%	5	UNITECH	2367	22.91%	27.64%	6.33%	35
POE	2370	33.20%	100.00%	33.20%	6	MIC	2315	62.95%	9.57%	6.02%	36
RT	2379	33.87%	90.75%	30.74%	7	Rectron	2302	11.14%	52.30%	5.83%	37
RITEK	2349	30.41%	100.00%	30.41%	8	D-LINK	2332	41.27%	13.91%	5.74%	38
POTRANS	2378	100.00%	24.82%	24.82%	9	CHIN-POON	2355	24.58%	22.94%	5.64%	39
AVISION	2380	100.00%	23.90%	23.90%	10	GCE	2368	25.75%	20.82%	5.36%	40
HON HAI	2317	100.00%	22.60%	22.60%	11	MXIC	2337	20.50%	23.52%	4.82%	41
ACER	2306	100.00%	20.18%	20.18%	12	YAGEO	2327	8.29%	57.66%	4.78%	42
GIGABYTE	2376	70.63%	28.01%	19.78%	13	COMPEQ MFG	2313	30.23%	14.80%	4.47%	43
CHROMA	2360	21.79%	85.89%	18.72%	14	WUS	2316	23.72%	18.69%	4.43%	44
MSI	2377	74.44%	24.87%	18.51%	15	MTI	2314	19.06%	22.40%	4.27%	45
COMPAL	2324	67.60%	27.09%	18.31%	16	BENQ	2352	70.52%	6.03%	4.25%	46
CMC	2323	20.46%	85.88%	17.57%	17	LPI	2369	17.84%	21.35%	3.81%	47
ELITEGROUP	2331	67.86%	24.83%	16.85%	18	AURORA	2373	51.51%	7.19%	3.70%	48
UMC	2303	31.44%	52.09%	16.38%	19	TATUNG	2371	47.94%	7.08%	3.39%	49
SDI	2351	22.22%	71.52%	15.89%	20	Q-RUN	2354	100.00%	2.79%	2.79%	50
ARIMA	2381	82.80%	19.14%	15.85%	21	Lite-On	2301	35.43%	7.80%	2.76%	51
WINTEK	2384	27.45%	47.37%	13.00%	22	DELTA	2308	39.22%	5.76%	2.26%	52
WEC	2344	29.57%	42.67%	12.62%	23	ASKEY	2366	46.06%	4.48%	2.06%	53
SIS	2363	29.24%	40.26%	11.77%	24	SILITEK	2310	46.65%	3.98%	1.86%	54
USI	2350	73.83%	15.78%	11.65%	25	PICVUE	2333	17.26%	9.89%	1.71%	55
INVENTEC	2356	89.73%	12.68%	11.38%	26	TECOM	2321	50.76%	3.35%	1.70%	56
SYNNEX	2347	100.00%	11.04%	11.04%	27	SOLOMON	2359	26.80%	5.60%	1.50%	57
ASE	2311	19.90%	48.70%	9.69%	28	FIC	2319	62.30%	1.44%	0.90%	58
TMC	2338	9.69%	100.00%	9.69%	29	BTC	2341	42.55%	0.27%	0.11%	59
ACER	2353	100.00%	8.16%	8.16%	30						

Table 4 The efficiency-effectiveness matrix of 59 E-companies



### Appendix 1: Financial Data of the Firms in the Empirical Study

Company	Code	Sales	Profit	Operating Revenues	Capital	Asset	Employee
Lite-On	2301	12,743.00	807.00	393.00	5,245.00	16,093.00	1,236
Rectron	2302	1,933.00	290.00	160.00	1,811.00	6,183.00	265
UMC	2303	29,147.00	10,498.00	5,521.00	65,612.00	146,139.00	3,452
ACER	2306	128,243.00	7,309.00	3,737.00	30,328.00	87,152.00	5,323
DELTA	2308	21,885.00	3,648.00	77.00	7,121.00	29,329.00	3,864
SILITEK	2310	14,378.00	1,015.00	210.00	3,271.00	13,355.00	934
ASE	2311	17,499.00	7,795.00	3,223.00	19,747.00	50,456.00	5,635
COMPEQ MFG	2313	12,965.00	1,188.00	763.00	5,611.00	19,980.00	4,391
MTI	2314	2,973.00	719.00	168.00	2,554.00	5,252.00	867
MIC	2315	30,260.00	1,735.00	1,057.00	7,623.00	23,014.00	1,986
WUS	2316	5,916.00	357.00	386.00	3,810.00	10,224.00	2,517
HON HAI	2317	51,813.00	7,413.00	4,119.00	10,496.00	50,338.00	1,300
FIC	2319	46,478.00	46.00	242.00	13,340.00	38,538.00	3,687
TECOM	2321	8,426.00	432.00	104.00	1,850.00	5,784.00	598
CMC	2323	13,392.00	7,463.00	4,586.00	9,572.00	41,120.00	2,747
COMPAL	2324	47,018.00	5,398.00	4,571.00	11,717.00	37,942.00	2,857
SPIL	2325	11,916.00	1,507.00	1,571.00	11,271.00	23,443.00	4,383
YAGEO	2327	3,744.00	1,832.00	630.00	11,788.00	29,330.00	1,230
TSMC	2330	73,131.00	24,650.00	25,917.00	75,726.00	161,423.00	7,460
ELITEGROUP	2331	10,901.00	932.00	1,059.00	1,531.00	5,901.00	222
D-LINK	2332	10,313.00	705.00	556.00	3,011.00	10,249.00	1,303
PICVUE	2333	4,191.00	410.00	127.00	5,397.00	9,874.00	1,176
MXIC	2337	16,612.00	907.00	1,543.00	19,644.00	49,896.00	3,109
TMC	2338	1,563.00	71.00	105.00	2,673.00	6,146.00	180
OPTO	2340	3,649.00	295.00	359.00	2,824.00	7,037.00	726
BTC	2341	8,188.00	118.00	7.00	2,310.00	7,191.00	669
SYSTEX	2343	7,482.00	901.00	659.00	3,242.00	9,432.00	1,216
WEC	2344	31,009.00	4,446.00	4,903.00	29,274.00	100,889.00	4,093
ACCTON	2345	9,605.00	474.00	698.00	2,347.00	10,913.00	1,206
SYNNEX	2347	39,000.00	1,734.00	1,564.00	3,322.00	17,708.00	1,043
RITEK	2349	14,314.00	5,307.00	5,772.00	5,148.00	53,790.00	2,797
USI	2350	28,906.00	1,412.00	1,700.00	3,989.00	17,797.00	3,375
SDI	2351	1,950.00	125.00	225.00	1,483.00	3,696.00	811
BENQ	2352	37,902.00	2,170.00	800.00	7,889.00	33,817.00	1,739

ACER	2353	18,148.00	571.00	577.00	1,621.00	7,796.00	858
Q-RUN	2354	15,050.00	74.00	168.00	1,457.00	4,959.00	145
CHIN-POON	2355	4,620.00	418.00	342.00	1,742.00	7,054.00	1,407
INVENTEC	2356	63,780.00	3,162.00	2,870.00	11,350.00	36,472.00	3,922
ASUSTEK	2357	48,999.00	14,285.00	12,619.00	11,454.00	48,646.00	4,213
SOLOMON	2359	6,127.00	386.00	119.00	2,385.00	9,119.00	552
CHROMA	2360	2,159.00	472.00	349.00	1,522.00	3,924.00	522
SIS	2363	10,840.00	1,960.00	1,704.00	4,877.00	24,705.00	909
ASKEY	2366	7,564.00	272.00	124.00	1,646.00	5,689.00	1,152
UNITECH	2367	4,926.00	334.00	450.00	2,992.00	8,395.00	1,741
GCE	2368	6,029.00	471.00	440.00	2,673.00	9,413.00	1,969
LPI	2369	2,150.00	84.00	86.00	2,083.00	4,356.00	1,406
POE	2370	1,602.00	252.00	161.00	1,265.00	2,917.00	490
TATUNG	2371	61,477.00	4,630.00	1.00	36,764.00	95,465.00	18,633
AURORA	2373	15,220.00	898.00	425.00	4,961.00	12,677.00	2,564
ABILITY	2374	2,302.00	65,374.00	34.00	1,735.00	2,800.00	546
GIGABYTE	2376	16,166.00	1,665.00	1,794.00	2,144.00	9,131.00	1,348
MSI	2377	15,800.00	1,392.00	1,562.00	1,872.00	10,554.00	1,759
POTRANS	2378	2,089.00	308.00	92.00	951.00	2,748.00	520
RT	2379	3,197.00	740.00	785.00	1,510.00	3,838.00	303
AVISION	2380	6,337.00	479.00	538.00	768.00	3,205.00	517
ARIMA	2381	39,536.00	2,810.00	2,753.00	5,830.00	22,825.00	2,123
QCI	2382	75,307.00	9,249.00	8,517.00	11,533.00	38,947.00	3,475
EMC	2383	1,675.00	94.00	138.00	1,176.00	2,317.00	246
WINTEK	2384	4,169.00	451.00	613.00	1,597.00	5,033.00	1,303

Source: All financial data obtained from Taiwan Stock Exchange Corporations (TSEC)

Fiscal Year Ending is Year 1999

# e-beauty: A Successful Model for B2C Business

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## Abstract

This is a case study based on an online skincare and markup products retailer, e-beauty. The raw materials for the authors' analysis come from a close observation of its marketing tactics, operating environment, as well as comments from online free speakers, some "offline" female interviewees, and reported public spoke made by managers of the company. From a neutral perspective, the authors draw conclusions on the integration of various aspects of the facts with the aid of some well-established marketing principles and theories. Findings suggest that online retailers might go profit by taking the virtues of both "online" and "offline." In specific, instead of tirelessly pursuing totally virtualization, some traditional non-electronic and traditional marketing practices can be used to strengthen the area where "Internet" is weak. In practice, the authors suggest that judging from a consumer's perspective, or customer orientation, is the rule of thumb for the choice of appropriate marketing strategy and tactics.

## 1. Introduction

Online shopping, a prosperous business area which attracted great interests even several years ago, has undergone significant drawback. People's dream on Internet giant was dashed to the ground overturn with the astonishing decline of the NASDAQ's stock index. In recent years, many online retailers shut down one by one, so that people almost forget some of them are once famous or panegyricized. Amazon, once the most successful online bookstore, has also felt into the situation of struggling for survival.

As the e-business is surrounded in a worldwide stagnant environment, an online retailer, e-beauty, shows lights on a new avenue for B2C online business. e-beauty (<http://www.nicebeauty.com>), founded in Taiwan, April 2000, is an online retailer which offers electronic commerce platform selling women makeup and skincare products, providing health and fashion suggestions. It operates nearly 200 products from seven brands including Dr. Bella, Serene, Roberta di Camerino and KyuBuTo ReDinGu etc., among which Dr. Bella is the most important one. Only half a year later, the company reached balance and every dollar turned into profit since that. Until now, it has more than 180,000 members in Taiwan, monthly sales of more than HK\$5,000,000. On 8 October 2001, it established new business in Hong Kong (<http://hk.nicebeauty.com>).

How can e-beauty be so successful in online B2C practice? What's the difference between e-beauty and most flat online retailers? The implications under its success need to be dug up to guide online enterprises that are struggling on the edge of survival and those that intend to step into this

area. A detailed investigation of this case was conducted to answer these questions. The raw materials for the authors' analysis came from comments from online free speakers, some "offline" female interviewees, and reported public spoke made by managers of e-beauty.

This case study reaches the conclusion that the extraordinary success of e-beauty ascribes to its splendid combination of online virtues with traditional business advantages, with the two complementary with each other. The combination effectively lowers consumers' perceived risks on online retailing, builds strong brands by providing various concrete and psychological benefits, targets and segments consumers implicitly while efficaciously. These measures adopted help reduce running expenses, induce tryout intention, and protect security. In turn, they lead to increased sales and profits. In the following section, the author first provides an overall description and analysis of e-beauty's practices in every main aspect. Then, synthetic remarks are provided based on the former work.

## 2. The Characteristics of the Products e-beauty Sell

It is said that among every \$1000 spent on makeup and skincare products, \$600 flow into the pockets of ad-agents and middlemen. This industry is a highly profitable business and the high costs are eventually born by end consumers. Li Junyan, senior manager of e-beauty in grant China area, said: "Through Internet, e-beauty makes possible for manufactures to face mass consumers directly, which significantly reduces the intervention from distributors and retailers, and thus increases cost efficiency. Therefore, e-beauty can charge competitively attractive prices for good-quality skincare and makeup products from Europe, America and Japan." Liang Yangming, the senior manager of e-beauty emphasized: "e-beauty help consumers to realize 'spend every penny on your own beauty'."

For every product, e-beauty provides colorful product photo as well as detailed description of its intergradient, function, usage and application, which make prospective consumers knowledgeable of all fundamental aspects of the product. "It is not enough, however. On the condition that I'm not familiar with a skincare brand, no matter how splendid it is boasted by the seller, I'll be hesitate to buy one unless I have a tryout in person" expressed by many interviewees. So, how to induce probation seems the first critical step toward profit, especially for e-beauty since it sells unknown brands. In addition, creating strong brand reputation is equally vital in personal care industry as well.

### 3. Brand Building

With the help of Internet, it is possible for e-beauty to charge low prices. "Price is one thing. I care more about the brand itself." "Using products of prestigious brands like Lancome, Shiseido or H<sub>2</sub>O makes me feel younger, safe and psychologically fulfilled." Given that consumers know nothing about Dr. Bella, how to make a brand in obscurity well known is the biggest challenge to gain consumers' belief.

To make consumers appreciate the brands sold by e-beauty, a photo of Wang Zuxian, a famous female actress known by Chinese, published on the website. If you click on the photo, a shortvideo in which Wang Zuxian advertises for e-beauty and its products will show. Advertisement by a celebrity increases the credibility of the contents of the website and raises the admiration for brands associated with the advertising. Somewhat, it can also be taken as a kind of warranty. In addition, compared with TV ad, ad on Internet is much cheaper, can be published for a longer time and can be accessed whenever you want. So the ad can be accepted more actively than those that are released through traditional media.

The openness and freedom of Internet make it possible to separate building a strong brand with expensive agent fees, advertising fees and rents.

### 4. Induce Probation

The website also promotes extensively for its free gifts to induce probation. Every month, e-beauty provides 3 to 5 free skincare or makeup products with prices ranging from HK\$300 to HK\$500 for members (free membership). To cover the material and transportation costs, e-beauty charges HK\$45 or NT\$180 for every free gift.

"The volume and quality of free gifts are parallel to normal products on shelf. We turn the money that is traditionally spent on advertising and special shelves lease into products for consumers to have a tryout." Critique from competing websites responds that e-beauty's so called "free gift" is just a kind of "extensive promotion ploy". Anyway, the charge of "HK\$ 45" cannot be set equal to "free" apparently. The authors think that the success of this measure can be contributed to the following reasons.

From the viewpoint of consumers, different from in other circumstances, consumers can get a so called "gift" in normal volume, they have free membership and unlimited right to ask for "gifts", and the price is cheap even for normal products, especially when the retailer makes fantastic utilization of reference price effect. In specific, the regular prices of "gifts" are labeled up to several hundred of dollars, which are comparable to high-level skincare products. Perhaps no rational consumers will buy from e-beauty at these prices. In other words, the prices are unauthentic and thus be suspected. However, extensive literature on reference price shows that consumers are affected by exaggerated advertised prices even though they do not trust them fully and this effect can be embodied on purchase behavior. In this case, consumers unawares take the high advertised "regular" prices as reference, based on which "HK\$ 45" is judged and perceived to be very cheap. This altered price perception will lead further to increased

purchase intention and even real purchase behavior. Responses from Internet free speakers show that they are apt to take the risky (or chance). "While it is priced so low, I don't mind to be cheated and would like to have a try." The low prices also lower consumers' expectation on the performance of the products. So, consumers are more easily satisfied. "It's astonishing, I didn't expect products with so high quality" an Internet user gave comments after she got her free gift. In addition, lower price can greatly reduce consumers' perceived monetary lost and make consumers' curiosity affordable.

From the retailer's perspective, on the other hand, its operations costs and advertising expenditures can be controlled within a low level with the help of Internet. Also, its brands are not worth so much to be charged as famous brands. These grant that it could be profitable even at the price for "free gifts", since many middlemen and associated costs are saved.

Some research showed that if products are mainly judged by searchable attributes, e.g., price, intergradient, Internet is a good choice to sell this kind of products; on the contrary, if non-searchable attributes, e.g., smell, handle, of products are significant for consumers' buying decision, selling solely online is not a wise option. Skincare and makeup products can be roughly categorized into the later type. Thus, inducing probation is a countermeasure to tackle the limitation of Internet.

e-beauty website absorbed 30,000 members by the end of the first month after its setting up. During the first three months, it sent out 40,000 gifts. Now, e-beauty sends out 80,000 gifts every month. In August 2001, it even created a record of sending out 40,000 gifts within two days and a half.

### 5. Payment and Logistics

Instead of solving the biggest headache in B2C electronic commerce, logistics and payment, along the prevailing thinking, e-beauty cooperates with "offline" convenient chain stores, 7-eleven.

7-eleven, the biggest retailing network in Hong Kong, is composed of 441 convenient chain stores and located almost everywhere in Hong Kong. It provides clean, comfortable and kind shopping environment, fresh, quality products, as well as speedy and convenient service. Every month, there are more than 20,000,000 capita buy from 7-eleven. To finish their orders online, consumers are required to indicate which 7-eleven store they would like to draw their ordered products. After a consumer makes order or asks for free gifts online, she/he will receive a confirmation email assuring the product ordered or gifts asked, time period to draw product, the place to draw etc. Consumers need to pay in cash as soon as they get their ordered. Although consumers can't enjoy the convenience of getting goods while staying at home, it is almost equivalently convenient to drop by 7-eleven in Hong Kong. The cost would be much higher if goods were sent by post or FedEx, and consumers sometimes complaint they can't wait for the products at home in the daytime.

It is also preferable that consumers can pay by cash. According to many online surveys, privacy and security are

the most serious concerns preventing consumers from shopping online. The payment security is especially concerned. "I'll never give out my credit card number online." "It's too dangerous to give out my credit card information on the Internet." Consumers show their distrust on Internet when they need to pay and therefore they are hesitant to provide their credit card number. Cooperating with traditional convenient store seems a wiselolution.

## 6. Loose Shopping Environment

e-beauty also raises the freedom of consumers' choice by: 1) providing a relative long time period for consumers to draw the products (normally 6 days); 2) if consumers fail to draw the products, there is no monetary punishment, except that they will never get the chance to order free gifts if they fail three times. These measures free consumers from compulsory action, instead they create a loose and trustful environment, give room for consumers to "regret" and consider more. They can help to raise consumers' favor on e-beauty and appreciate its consideration. "We make consumers moved continuously," said Liang Yangming.

## 7. Targeting and Segmentation

While e-beauty takes advantages of various means, it doesn't forget the basic concept in marketing, targeting and segmentation, especially in this highly competitive industry, or you might lose the whole market.

The idea segmentation can be embodied everywhere. It emphasizes that its products are designed according the Eastern skin type. The websites are written in Chinese characters, the celebrity chosen are highly famous among Chinese, it distributes goods just locally, and consumers need to pay on domestic or local currency. For most online retailers, with the help of Internet, they try to reach consumers globally. While for e-beauty, it seems somewhat "myopic". In Taiwan, there is <http://www.nicebeauty.com>, while in Hong Kong, there is <http://hk.nicebeauty.com>. e-beauty targets to Taiwan people and Hong Kong people respectively. All the above facilitate the transaction process in the target market, reduce the risks from extraordinary factors, e.g., exchange rate, product performance failure, and make the shopping experience more convenient and enjoyable.

e-beauty is also aware that although loyal consumers are surely important and crucial to the company, a great proportion of skincare or makeup users are always switching and apt to take bargains, especially in a highly competitive industry. To well grasp this segment, the "free gift" program is always in operation, with the products offered varied every month.

## 8. Conclusion

Overall speaking, we think the success of e-beauty lies mainly in its combination strategy, in specific, it takes the advantages of Internet media; at the same time, it retains benefits of traditional business practices, e.g., paying in cash, as a supplementary. In other words, each works to strengthen the area where the other is weak. Compared with online retailers that tirelessly pursue being totally virtualized and take great efforts and investment to catch up

in logistics, e-beauty abandons such efforts, instead it adopts seemingly lagged manner, something between modern and tradition.

It is easy said than done. The case manifests that thinking from consumers' perspective is a useful device in guiding detailed measures or practices. No matter how advanced a technology or practice is, whether consumers perceive it favorable or unfavorable is the theme. An online retailer must see through its consumers' eyes to judge what advantages of Internet and traditional business practices respectively should be retain. Some traditional marketing concepts, e.g., target, segmentation, brand reputation, are still useful or even fatal for online retailers.

In practice, the author thinks that e-beauty's practice can be best used for reference when setting up online retail stores selling high value-added unknown consumption brands in high population areas having developed offline retailing network charged by just a few holders.

# Payment Barriers in China's B2C Business

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## Abstract

With the entry into the WTO, China has made a lot of progress in its e-business. However, there are still some barriers that limit the development of e-business in China. One of the most difficult hurdles might be the fragile online payment system. According to The first DHL Global E-commerce Report, in mature Internet countries, online payment is no longer a problem. For instance, six out of 10 companies in the US (60%), Australia (61%) and Finland (58%) say payment is not a barrier to e-commerce. But less mature markets including China consider payment a barrier. This paper mainly discusses the payment barrier to B2C Business in China, and then forwards some suggestions on how to remove those barriers on the basis of analyzing the case of BOLChina—A successful B2C model from Germany. Also, some conclusions are given to make it more clear that China should break the ice of payment barriers on the way to the bright future of its e-business.

## 1. Current Situation of China's Internet Users

Since a certain number of Internet users are the foundation of e-business especially the base of B2C business, it's quite imperative to discuss the current status of Internet users in China and the main characteristics of their online buying behaviors. This section describes the population of Chinese Internet users and their basic online shopping behaviors.

### 1.1 Growing Online Population

The China Internet Network Information Center (CNNIC) in January 2002 claims that the number of Internet users in China has reached 33.7 million, with 6.72 million using leased lines and 21.33 million using dial-up connections. The "Statistical Report on Internet Development in China" said that the number of users accessing the Internet via both means was only 5.65 million. Additionally, another 1.18 million people are connected through appliances such as mobile telephones and various home information appliances. According to the reports made by CNNIC in the past four and a half years, we can see clearly the development of Internet in China (see Exhibit 1 and Exhibit 2)[3].

Exhibit 1: The Increase of the Computer Hosts in China (in Thousands)

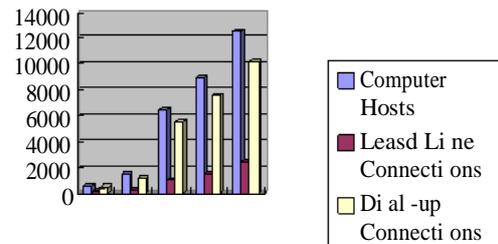
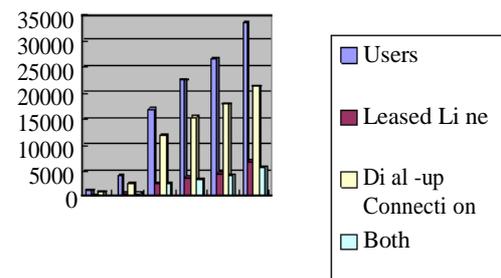


Exhibit 2: The Increase of the Internet Users in China (in Thousands)



With 1.3 billion potential e-consumers, it is likely that the Chinese market will have a ramatic effect on world e-commerce. However, Internet penetration rate in China is currently low when compared to the U.S., but is growing at a tremendous rate. Citing research by CNNIC Semiannual Surveys, the report said that Internet penetration is currently only 2.6 percent in mainland China which reflects the fact that China's e-business is quite fledgling.

Even though many mainland Chinese do not have Internet access at home, Internet penetration rates for mainland China were once doubling every six months from October, 1997 to July, 2000, though the speed slowed down in recent two years, the absolute number of Internet users still increased at a quick pace, and this has laid a solid foundation for China's B2C business.

### 1.2 Favorite Items Bought Online

Only 31.6% of Chinese Internet users have had some experience of buying online. The most popular goods for Chinese online shoppers are books and magazines,

purchased by 58.0% of those who shopped online at least once. Computer appliances(33.7%) were ranked the second item that Internet users bought. The rest popular items are: Photographic Equipment 3.6%, Communication Appliance 15.5%, AV Equipment 34.4%, Living and Housing 11.6%, Clothing 4.4%, Family Electrical Appliance 5.6%, Sports Equipment 4.4%, Medical Care Services 3.1%, Present Delivery 14.7%, Financial and Insurance Services 2.6%, Ticket Ordering 9.7%, Educational Services 11.8%, Others 3.1%.

### 1.3 Reasons to Buy Online

48.3% of Chinese Internet users bought online because they thought it can save time by buying online, and “Easy to Operate For Fun and Curiosity (31.5%)” and “Reduce Costs(38.8%)” are the reasons next to “Saving Time”. Interesting is the following reason of “For Fun and Curiosity (31.5%)”, which was ranked the 4<sup>th</sup> purpose for users to purchase online.

## 2. Payment Barriers to B2C Business in China

### 2.1 Barriers in China’s Banking System

Credit cards are very inconvenient to use in China because banks don’t share a centralized settlement system. Different banks issue their own credit cards and the cards can only be used in certain shops and restaurants and hotels, etc. Each bank has its own territory and they don’t talk to each other. Cash, instead of credit cards, is the dominant payment method.

Besides, banks don’t have a complete network among all of their branches, so they don’t promote credit card usage. Trying to own a credit card in China is a difficult process. And, very often, consumers are given very little credit lines so that a credit card virtually works as a debit card.

Therefore, online payment is a big bottleneck to e-commerce. A Web site has to establish settlement with different banks before they can accept all different cards from its users. Most B2C sites are actually using the Web as a catalogue only, while collecting the money offline at the time of purchase at a consumer’s home or office.

### 2.2 Online Shopping Barriers

Just as elsewhere in the world, the Chinese online shoppers have their trouble regarding every aspect of online shopping behavior. Concerns about security and quality of goods are cited as primary online shopping barriers: (see Table 1) [2]

Inconvenient payment ranks the third place in online shopping barriers, but the value and attitude of Chinese people towards credit cards attributes partially to this barrier. According to a research made by China Women Journal and Mastercard, among the banking card holders, 62% of them possess 1 to 3 cards, 36.6% of them possess

3 to 6 cards, and the rest of them even hold more than 6 cards. However, only 34% of them use credit cards occasionally, 15% of them never use any card [5]. The trouble is that few Chinese people trust the Internet for business. A Chinese saying goes that one should “never let out your hawk until you see the hare.” So, frankly speaking, providing a more effective way of paying online will not solve the “attitude” problem of Chinese online purchasers.

**Table 1 :Online shopping barriers in China**

Online shopping barrier	Percent
Security can not be guaranteed	31.0%
Inconvenient Payment	11.8%
Quality of products, after service and credit of the producer can not be guaranteed	30.2%
Delivery is time wasting, the channel is not expedite	13.9%
Unattractive Price	6.3%
Unreliable Information	6.3%
Others	0.5%

Source: Jan, 2002 CNNIC

### 2.3 Trust Issues

Many surveys made both domestically and abroad showed that most Chinese online shoppers were also distrustful of companies that exist only in cyberspace without a brick-and-mortar counterpart. According to the surveys, few Chinese would make a purchase from an e-tailer that they had never heard of before [4].

Since the Chinese online market is just in its infancy, Steve Diller, partner and head of eBusiness and Media Strategy at Cheskin thought that it's even more critical to pay attention to online trust, as technology penetrates global markets, access to e-commerce won't be the issue, creating loyal relationships through service, authenticity, and trust will be key.

### 2.4 Other Related Barriers

Other related barriers include distribution of online shopped goods, the application of state-of-the-art technology in China’s e- business, etc.

As to the logistic system, which is another serious problem of e-commerce development in China, the successful online shops in China adopts a pragmatic method—to order online, to pay offline. Such a strategy is based on such a logic of trying to avoid much

involvement of delivery and transaction infrastructures. In fact, the development of delivery and transaction infrastructures is out of the reach of internet companies in China. The worst situation is that internet companies invest a lot of money to develop infrastructures that are supposed to be done by the government and other industries. When the infrastructures are not available, e-commerce companies should focus on building up information platform to make that part electronic and seek more physical solutions for delivery and transactions which is called partial e-commerce models. Unlike in the U.S., delivery function of online shops is contracted out to major courier firms such as UPS, FedEx, etc., the only viable delivery system to both business and homes is the state-owned Post Office. But the Post Office is notorious for being slow and mishandling goods. Foreign competitors, such as DHL and EMS are starting to have presence in large cities of Shanghai, Beijing and Nanjing, but they are targeting office buildings and the cost they charge is excessively high for an ordinary online shopper. So, a lot of Chinese online shops together with foreign ones are taking advantage of cheap labor resource in China to combine with electronic solutions. Physical solutions in delivery and transaction are not necessarily second best solutions in China since labors are still very cheap in China.

### **3. Some Suggestions on How to Remove Payment Barriers in China**

#### **3.1 Establish a far-reaching, well-organized payment system**

Dotcoms and B2C business in China could only achieve ideal growth after entered into long-term agreements with banks.

China lacks central credit clearing corporations, making the proliferation of credit cards difficult -- although debit bank cards number is over 350 million[4]. The tool that has transformed American on-line purchasing is therefore rare in China. Companies selling merchandise depend on cash-on-delivery and nascent debit card accounts for their commerce. Recognizing this obstacle, the People's Bank of China and the leading state-owned commercial banks are actively engaged in setting standards for secure payment through the establishment of certification authorities. Companies such as Capital Electronic Center are already filling the gap by facilitating on-line payment for any of 12 debit or credit cards issued by the major commercial banks. After such efforts, the off-line cash payment which is currently quite popular as a substitute is to be soon outmoded and replaced by a modern online payment

#### **3.2 Increase communication with global e-commerce outfits, publicize knowledge about e-commerce and Internet usage, and merge the modern Internet economy with the traditional business model.**

Any commerce model involves three infrastructures: information infrastructure, delivery infrastructure and transaction infrastructure. E-commerce models in western countries take big advantage of well-developed delivery infrastructure and transaction infrastructure and try to manage information flow, goods flow and payment flow as much as possible with electronic solutions (complete e-commerce models). The internet strengthens information infrastructure and catalyzes E-commerce development.

#### **3.3 Establish A Strict Credit System Throughout the Country**

The credit system is also linked to popular perception. In the U.S., bad credit brings you lots of trouble. In China, wrongdoers are left too much leeway to correct things. How can we establish a credit system under such cultural views? So, it's necessary to set up such a credit system so that the questionable practice online will be punished.

#### **3.4 Establish An Efficient Delivery System**

Delivery is another serious problem to e-commerce development in China. The only viable delivery system to both business and homes is the state-owned Post Office. But the Post Office is famous for being slow and mishandling goods. Foreign competitors, such as DHL and EMS are starting to have presence in key cities of Shanghai, Beijing and Guangzhou, but they are targeting office buildings and the cost they charge is prohibitively high for an ordinary consumer.

How to get goods out to a consumer's door in time before he or she gets irritated is a huge problem. Or is there an alternative solution? Web sites in Japan are using Seven-eleven convenient stores as the distribution channel. Consumers purchase goods online but go to a Seven-eleven store to pick them up. But China should develop a more practical model of e-distribution since there is no such a chain store system like 7-11.

### **4. BOLChina—A Successful Case in China's B2C Market**

Bertelsmann is a Germany-based company offering books and other media products. Since its entry into China in 1995, Bertelsmann contributed to many cultural exchanges between Germany and China and today it strives to further develop the Chinese media industry through its products and services.

During Chancellor of Germany Kohl's first visit to China in 1993, Bertelsmann set its foot in China as a member of the German delegation. Bertelsmann then started negotiations with competent government authorities in Shanghai concerning the possibility of media cooperation. After a series of negotiations the Science and Technology Book Corporation under the Shanghai Press and Publishing Bureau and Bertelsmann Germany Holding GmbH signed a joint-venture contract

in July 1994. Subsequently, in February 1995, Shanghai Bertelsmann Cultural Industrial Company Limited was founded [1].

As a result Bertelsmann, one of the leading media groups in the world, entered China and opened a new chapter in its adventure in China: promoting cultural exchanges between Germany and China, sharing its successful experience with its Chinese counterparts, and providing a wide variety of media products to the Chinese consumers. At present, Bertelsmann's operation in China is not only based on the traditional book market, but also pervasively participates in the progress and further development of the Chinese cultural industry and advanced multi-media and e-commerce, shaping its unique professional service in the market.

While China's dotcoms are bruised by the heavy blow from the recent Nasdaq crash, Bertelsmann AG, the third largest media conglomerate in the world, is moving its China businesses onto the Web.

Aimed at exploring China's fledging multimedia market, Bertelsmann has launched an online media arm under the global brand umbrella of BOL.com.

BOL China ([www.bolchina.com](http://www.bolchina.com)), functioning as a platform to retail media and entertainment products in China, claims to be capable of dispatching 100,000 book titles throughout the country on a daily basis.

To run an online bookstore is nothing new in China and many firms have so far struggled in the industry.

Ekkehard Rathgeber, vice-president of Bertelsmann Direct Group East Asia and General Manager of Shanghai Bertelsmann Culture Industry Co Ltd, is upbeat about the online business for one reason: the strong brand of Bertelsmann and its traditional media businesses.

The initiative in China is part of Bertelsmann's global strategy of transferring its established business onto the Web.

Thomas Middelhoff, chairman and chief executive officer of Bertelsmann AG, declared the corporate strategy to focus on development of core content services together with e-commerce. The success of this company's online business is partially due to the pragmatic way of using the traditional COD payment pattern and the cooperation with Post Offices in delivering its books to customers.

The company introduced its first book club to China in 1997. The club has been a great success in other parts of the world. The club's registered members in China have hit 1.5 million.

In 2000, Bertelsmann's revenue in China was 140 million yuan (US\$16.87 million).

## 5. Conclusion

(1)China's e-commerce and dotcoms will only switch to a rapid and healthy growth track after the establishment of a sound basic infrastructure base especially the payment system.

(2)Now is not the proper time for the explosion development of B2C business and dotcoms because China's dotcoms are merely castles in the air, for they

have no fundamental support. Some experts say that "The highway of Internet is supported by weak pillars like paper pokers." Maybe this is not exaggeration.

(3) A logistics and distribution system is another barrier that has hindered the growth of B2C business. After more than 50 years of development, a State-owned comprehensive logistic and distribution system has been set up with the participation of department stores, grocery stores, book stores and post office. The dotcoms could utilize the delivery capability of traditional businesses instead of setting up a new system by themselves.

(4) China's infrastructure including payment system is poor but improving. For example, China's big four commercial banks - the Industrial and Commercial Bank of China, the China Construction Bank, the Agricultural Bank of China and the Bank of China - have yet to reach every corner of the country, once they realize that online payment system can bring huge profits to them, they are bound to take part in the improvement of online payment system proactively.

## References

- [1] Bolchina, <http://Bolchina.com>
- [2] CNNIC, Statistical Report on Internet Development in China, 1998 through 2002, at <http://cnnic.net.cn/>
- [3] CNNIC, Statistical Report on Internet Development in China, January, 2002, at <http://cnnic.net.cn/>
- [4] Global Reach, Global Internet Statistics: Sources & References, June, 2001, at <http://glreach.com/globstats/refs.php3>
- [5] Mei Shao hua, Credit Cards in China—Enough Cards, Rare Usage, Economic Daily, August 16, 2001

# A Blueprint for Applications in Enterprise Information Portals

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## Abstract

Electronic Commerce (E-Commerce, EC) is thoroughly changing business models of organizations (governments, corporations, and communities) and individuals the way of living and working. However, the major success will accrue to those companies that are willing to transform their organizations and business processes, which is the scope of e-Business. An Enterprise Information Portal (EIP) provides real time information and integrated applications to knowledge workers, employees, customers, business partners and the general public as well. Effective applications of EIP facilitate high quality strategic decisions. That is, an EIP can enhance an organization's productivity, improve the collaboration to facilitate E-Commerce and gain competitive advantages. However, the EIP solutions are usually too expensive to small businesses. With Enterprise Application Integration (EAI) approach, this paper presents an economic way to design a low-cost EIP that leverages existing systems. Moreover, a prototype is implemented to show the feasibility.

For the external data access, the web mining technology is utilized to mine some relevant and valuable web contents from the Internet and put these contents into the document warehouse. By combining the textual information inside the document warehouse and the numeric data from the data warehouse, competitive advantages can be provided over those who work with just the numbers.

Keywords: Enterprise Application Integration (EAI), Enterprise Information Portal (EIP), E-Commerce, Workflow, XML, Web Mining, Document Warehouse

## 1. Introduction

Intel Corporation president and CEO Craig Barrett said that if the Taiwanese industries want to speedup Internet growth and E-Commerce cooperation that are the first an imperative duty. He thinks that the ASPs don't exist after 5 years because all companies become ASPs. Figure 1 shows a prediction of E-enterprise's growth by IDC. Taiwanese businesses could survey outsourcing of IT and businesses refocus on overarching business objectives such as customer satisfaction, the core of competition ability and increased competitive advantages, as it controls only the

technologies critical to those programs. July, 2002. According to the IDC report, the EIP solution software not only increases, but also tendency of obvious growth. It estimates that the investment from five hundred million to three thousand million between 2001 and 2006. The growth of Internet technologies has unleashed a wave of innovations that change the way business is conducted. These shows demand immediate attention for E-Commerce.

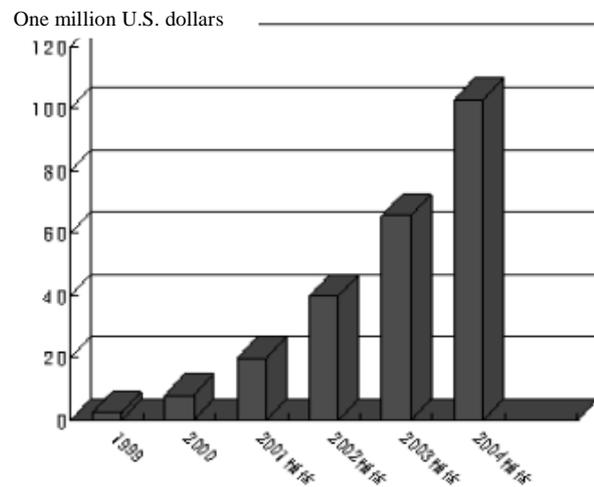


Figure 1 A prediction of e-enterprise's growth by IDC  
source: IDC

A corporate portal, also called an EIP, is generally defined as a personalized, single point of access through a Web browser to critical business information located inside and outside an organization. Some refer to a "Web top," rather than browser, to include handheld devices, mobile phones, PDA, ad-hoc network devices and other Internet appliances [21]. Portals gather information from one or more servers, as well as from the Internet, and deliver that information through a single, consistent interface. This gives users one interface to access all the required documents, e-mail, Web sites, competitive information, databases, and so forth for their jobs. It's also important to view the portal not only as an internal tool in an enterprise, but as one used by the extended enterprise, including partners, suppliers, investors, and customers. The portal is a basis of any e-business strategy. The EIP

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solution provides a single point of access to all structured and unstructured enterprise data. It is a concept for a Web site that serves as a single gateway with a company's information and knowledge base to employees, customers, business partners, and the public as well. The EIP effectively connects users to content in context, enabling true enterprise agility [1, 17, 20].

There are two key concepts to define an EIP: access and integration. Moreover, there are two problems of information management: "Isolate of Information" and "Island of automation". Thus EIP plays a critical deployment role in reengineering legacy systems. No matter systems reengineering or business reengineering can play complementary roles when performed in an integrated. They have been stereotypically and perhaps unfairly described as existing software systems whose plans and documentation are either poor or nonexistent. Generally, legacy systems are large and/or complex; developed using unstructured data with little programmatic support. A business has to handle several kinds of issues in building brand new systems or integrating some legacy system into an EIP system [12]:

- an efficient communication and project management among teams and organizations;
- Encouraging "contextual collaboration" or ad-hoc team communication around specific data sources;
- Defining, illustrating and managing the complex interactions among the players;
- Capturing and archiving the knowledge and interactions of all players in an enterprise such that it can be used as essential data in a knowledge management/decision support mode

In the backend, data mining technologies provide analysis data tools for knowledge workers, employees, customers and business partners.

The goal of this paper is to integrate all of the legacy system into a web-based interface, the prototype is provided to preview related technology, identify open issues, and demonstrate how to convert existing client/server systems into the Web. It is therefore organized as follow. In Section 2, some of the related features of the system description are described. A brief introduction of our prototype is in Section 3. The prototype implementation for Taiwanese small business is presented in this section. The contribution of this research, technical challenges, and future work are summarized in Section 4. Finally, conclusions are made in Section 5.

## 2. System description

The best way to embark on an EIP system is to select the target users and understand what information they need. The information can fall into a number of categories, including:

- unstructured content (documents, hypertext content, etc.)
- structured content (data stored in relational or other types of databases)

- news (either free or for-fee)
- groupware application data (such as Lotus Domino or Microsoft Exchange)

With EIP, information can be easily organized, searched and packaged, users can friendly select what they want to access.

Our EIP system provides recommendation engines. Even if you aren't familiar with this term, you might have already experienced the functionality on E-Commerce sites like Amazon. At Amazon, after a selection you made, a recommendation list of best sale books, CDs, or movies are provided for you. This recommendation function is a useful feature to stimulate users' purchases [13].

### 2.1 Enterprise Information Portal (EIP)

Comparing with the MyYahoo!, a primary function of an EIP is to aggregate content from disparate sources [14]. As most companies have an environment of disparate legacy systems, application, processes, and data source, which typically interact by a maze of interconnections that are poorly documented and expensive to maintain. An EIP has quickly become important business infrastructure as they aggregate disparate data sources and attempt to unify and organize information for decision support. The integration of EIP and collaboration technology allow the organizational communication processes to be unified into single information source creating a complete and usable archive of all transaction, including the data, discussion about the data, and the decision-making process.

In addition to creating a knowledge archive, the chaotic and ad-hoc nature of B2B communication demands definable, demonstrable, and repeatable processes which companies can use to conduct business models.

### 2.2 Web Mining and Business Intelligent

How does user deal with gargantuan information repositories for every bit of business trivia? Moreover, the sources of data were of the old realm of business: point-of-sale terminals, inventory databases, transaction records. Attempting to understand the data, several analysis tools are used: statistical tools, OLAP systems, and Data Mining. Data Mining is the best of these tools. It is natural for one would want to analyze this data with the best data mining techniques available. The results of the data mining - the rules which say which customers are likely to buy what products at the same time, or who is about to switch to your competitor [4, 8, 9,11].

When customers visiting a web site, they provide their information based on the content of the web site. There is so much information is interesting, such as: which links customers click, what kind of web site contents they stop by longer, which terms they use to search, and when they browse. Some customers might fill out a lifestyle survey or provide names and addresses information to the visiting web site. Complex content also contains important information, such as words in articles, job descriptions and resumes, and features of competitive or complementary

products. Usually, all information is stored in a database. This results in a lot of information available on Web sites, but web users probably can not use it in a best way. To solve this problem, web-mining techniques can be used to find buried patterns in databases, and report or act on those findings.

### 3. System architecture

Our primary goal is to implement a web-based portal, called MyPortal, with a web-mining technique. Basically MyPortal would integrate business's legacy systems, personalized interface, and existing heterogeneous database [19]. Figure 1 shows the system architecture of MyPortal.

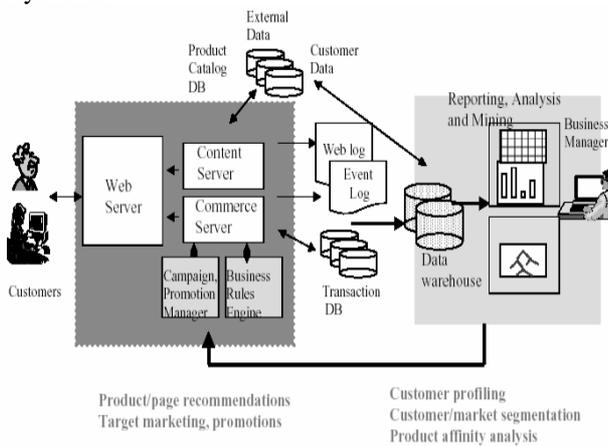


Figure 2 MyPortal system architecture

Figure 3 depicts a mapping of N-tier architecture and its implementations in MyPortal. N-tier architecture would simplify the system development environment and maintain the system easily.

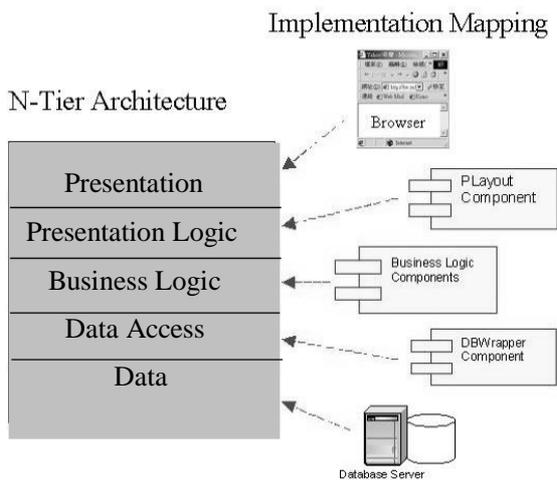


Figure 3 MyPortal mapping of N-tier architecture and its implementation

#### 3.1 System Environment

The implementation platform is MS-window-based personal computer. In MyPortal, programming tools cost around one hundred thousand NT dollars that is affordable to most Taiwanese small businesses. System configuration

is listed as the following:

- System Environment:
  - ◊ Operation System: MS Windows 2000 Server or later
  - ◊ Web Server: MS IIS 5.0 or Apache HTTP Server
  - ◊ MS SQL Server
- Application Environment:
  - ◊ Integrated Development Environment: MC C++, ASP
  - ◊ MS FrontPage 2000
  - ◊ Java Server Page
  - ◊ JAVA 2

#### 3.2 System Implementation

Figure 4 shows the prototype of MyPortal application. There are two major parts of the whole MyPortal: The portal and WMIS (Web-Mining Information System). MyPortal provides a personalized web-based environment and supports a web-mining technique. The WMIS provides general contents and news contents [6].



Figure 4 shows the prototype of MyPortal application

#### 3.3 WMIS Application

The major function of WMIS is to provide interfaces for user to input keyword data and find the related information. In WMIS users have to create “personal information needs profile” first, there are two major methods: Input Keyword and Online Help Document. Online Help is txt-format file for supporting Chinese punctuation [5, 7, 10].

When the user profile created their profile then web document-agent can retrieve, analyze and converge web pages for user. The query interface further provides searched results based on request of keyword, author's name, title or publishing date. Furthermore, user can recommend other valuable browsed homepages or provide “Negative Feedback” to WMIS system that can filter non-related homepages. Figure 5 shows results of user query and figure 6 shows advanced query interface in WMIS [2, 3].

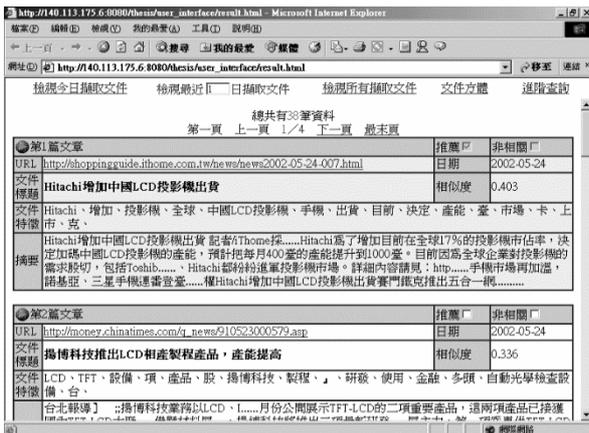


Figure 5 shows results of user query

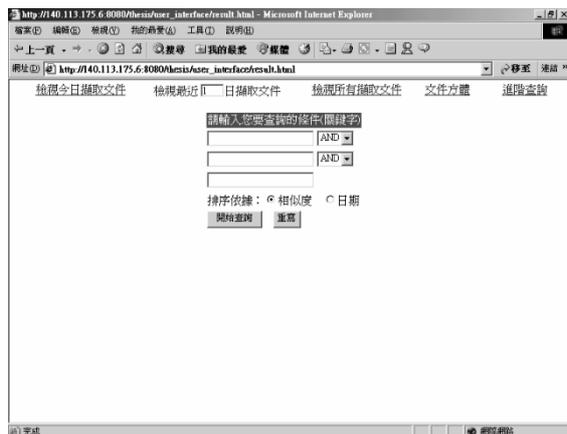


Figure 6 shows advanced query interface

Web mining agent: This is core of WMIS application there are five modules: pre-process document, retrieval web pages, document-related analysis, auto-retrieval abstract and process multi-dimension document. The detailed features of each module are described in the following paragraphs [18].

- Pre-process document module includes HTML tag omission, Chinese punctuation and feature retrieval.
- Retrieval web pages, this module can retrieve homepages through URL using existing net package of JAVA.
- Analysis document-related module uses “Vector Space Model” implement the module through “similarity object”.
- Auto-retrieval abstract module can automatically generate an abstract of retrieved document, let users easily understand web pages of contents and save storage space.
- Process multi-dimension document module converges every dimensions (including URL, title, publishing date, abstract) store in the document warehouse.

Especially mentioned, the words adopt “Tsai’s List of Chinese Words” of Chih-Hao Tsai<sup>1</sup> at University of

1 Words source: Chih-Hao Tsai  
<http://casper.beckman.uiuc.edu/~c-tsai4/chinese/tsaiword.zip>

Illinois.

### 3.4 MyPortal Application

Most companies have an IT environment with disparate legacy systems, applications, processes, and data sources. The system we proposed provides a single interface to access to all structured and unstructured enterprise data. Four design models, business user case model, use case model, analysis model, and design model, are available in MyPortal.

The basic schema of MyPortal is to utilize a web server and applications as the middle tier in a N-tier client/server architecture. With such a schema, it is easily to put existing business model over the Internet. The middle tier is then responsible for accepting the requests for database access initiated at Web browsers, initiating proper database transactions, and returning them to users through the Web server. Based on the idea, the N-tier solution can be designed and maintained more efficiently [15, 16].

### 4. Discussions

The approach presented in this paper can be enhanced in several aspects: First, The WMIS application can be extended to a multilingual support and enhanced to deal with all kinds of unstructured information. Second, query result cache and paging support can be added to improve data retrieving performance and resource utilization. Third, using middleware component technology, each of these distributed object components can interoperate smoothly in an integrated system. Moreover, there are several object-oriented and component-based development technologies, such as XML, CORBA and EJB (Enterprise JavaBeans), are available. These technologies would be helpful to develop a web-based system, such as WMIS Fourth, SSL, client-side authentication and a single sign-on should be supported in an EIP. Especially, the single sign-on can be integrated with the Windows logon, or it can be extended to support logon to back-end systems after a user has been authenticated to the EIP. A possible approach for achieving the above enhancement is to develop integrated application in the future work.

### 5. Conclusion

The employee can either use the desktop, notebook, PDA or ad-hoc network devices to access business databases simultaneously and browse the information with a web browser. This paper is a good entry for CIO, one in an organization's IT decision-making team and other interested in IT to understand an EIP solution for organizations. It integrates efficient information of all business intelligent by MyPortal application and provides quickly information search by WMIS application.

The enterprise collaboration portal can be available for every kind of businesses. It also becomes the source of a company’s most valuable asset: the collective knowledge from its employees, suppliers and customers. The “Myportal” prototype is based on the cost-saving

conception, it is especially to fit Taiwanese small business. With “Myportal”, it becomes possible to overcome the physical boundaries of existing organizations.

## Acknowledgements

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## References

- [1] C. Dias, "Corporate Portals: a literature review of a new concept in Information Management", *International Journal of Information Management*, 21, 2001
- [2] C. L. Yeh and H. J. Lee, "Rule-based Word Identification for Mandarin Chinese Sentences- A Unification Approach", *Computer Processing of Chinese and Oriental Languages*, Vol. 5, No. 2, pp. 97-118, 1991.
- [3] C. S. Peng, S. K. Chen, J. Y. Chung, A. R. Chowdhury, and V. Srinivasan (1998), "Accessing existing business data from the World Wide Web", *IBM System Journal*, 37(1), pp115-132.
- [4] Dan Sullivan, "Document Warehousing and Text Mining", John Wiley, 2001.
- [5] D. Green, "The Evolution of Web Searching", *Online Information Review*, volume 24, number 2, 2000.
- [6] Etzioni, O., and Weld, D. S., "Intelligent Agents on the Internet: Fact, Fiction, and Forecast," *IEEE Expert*, August 1995, pp.44-49.
- [7] G. C. Li, K. Y. Liu and Y. K. Zhang, "Identifying Chinese Word and Processing Different Meaning Structures", *Journal of Chinese Information Processing*, Vol. 2, pp. 45-53, 1988.
- [8] Inmon, W.H., *Building the Data Warehouse*, John Wiley & Sons, Inc., 1993.
- [9] Jun-Wei Yu, "Enriching Enterprise Data Warehouse by Web Mining Technology", Department of Management Science College of Management National Chiao Tung University, Master thesis, June 2002.
- [10] J. Y. Nic and M. Briscobois, "On Chinese Text Retrieval", *Proceeding of SIGIR*, 1996.
- [11] J. Yi and N. Sundaresan, "Metadata Based Web Mining for Relevance", *IEEE* 2000.
- [12] Kuang-Ming Chen, "AResearch of Enterprise Information Portal Design", Institute of Information Management College of Management National Chiao Tung University, Master thesis, June 2002.
- [13] M. M. Davydov, "Corporate Portals and e-Business Integration", McGraw-Hill, New York, 2001
- [14] MyYahoo!- personalize Yahoo!'s content, <http://my.yahoo.com>, 2002
- [15] R. Chartier, "Application Architecture: An N-Tier Approach - Part 2", <http://www.15seconds.com/issue/011219.htm>, 2001
- [16] R.R. Ling, D.C. Yen, and D.C. Chou (2000), "From Database to Web Browser: The Solutions to Data Access," *Journal of Computer Information System*, Winter 2000-2001, pp58-63.
- [17] R. Zahavi, "Enterprise Application Integration with CORBA- Component and Web-Based Solutions", John Wiley & Sons, New York, 2000
- [18] San, M., "Intelligent agents on the Internet and Web," *TENCON '98. IEEE Region 10 International Conference on Global Connectivity in Engery, Computer, Communication and Control*, Vol.1, pp.97-102.
- [19] S. Lawrence and L. Giles, "Accessibility and distribution of information on the web", *Nature*, 400, July 1999.
- [20] Ted Sun, "Web-Based Business-to-Employee (B2E) Model: The Strategic and Evolutionary Role in Electronic Business (e-Business) Framework", *Executive MBA Programs Chiao Tung University*, Master thesis, Feb. 2002.
- [21] W. A. Ruh, F. X. Maginnis, W. J. Brown, "Enterprise Application Integration", John Wiley & Sons, New York, 2001

# Atomicity Implementation in E-Commerce Systems \*

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## Abstract

Distributed databases with high performance and availability do not have the traditional ACID properties (Atomicity, Consistency, Isolation and Durability) because long duration locks will reduce the availability and the write performance. The problems of the missing ACID properties may be avoided by using approximated ACID properties, i.e. from an application point of view; the system should function as if all the traditional ACID properties had been implemented. The distributed approximated atomicity property manages the workflow of a transaction in such a way that either all the updates of the global transaction are executed (sooner or later) or all the updates of the global transaction are removed/compensated. In this paper, we will describe a flexible algorithm for implementing distributed approximated atomicity. Frank and Zahle [1] have described how to implement the other global approximated ACID properties.

We will illustrate our algorithm with E-commerce examples. If one of the partaking subsystems fails in a system for E-commerce, the approximated atomicity property will ensure that when an order is accepted, the payment and stock levels are managed automatically in the locations of the partaking banks and product stocks. Even logistics and/or production may be managed by using approximated atomicity.

We have cooperated with one of the major ERP (Enterprise Resource Planning) software companies in designing a distributed version of the ERP system with local autonomous databases in the different sales and stock locations.

*Keywords:* ACID properties, approximated atomicity, distributed systems, electronic commerce, ERP systems.

## 1. Introduction

In the transaction model described in this paper, the approximated atomicity property is implemented by using retrievable, pivot and compensatable subtransactions. The global consistency property does not exist in our transaction model. However, the concept *asymptotic consistency* can be used to create a consistent database state for e.g. datawarehousing [10]. The approximated isolation property is implemented by using countermeasures [1] to the isolation anomalies that occur when transactions are executed without isolation. The

global durability property is implemented by using the durability property of the local DBMS systems.

Our algorithm for approximated atomicity implementation is a transaction pattern with all the necessary types of database accesses, but without the application logic. This transaction pattern must be used by all distributed transactions. By using our transaction pattern, the development costs for new applications may be reduced.

By means of examples, we will illustrate how to implement the approximated atomicity property in E-commerce systems. There are many different workflow architectures for E-commerce systems [12] and our transaction pattern cannot cover them all. However, our transaction pattern can manage the distributed workflow needed in most E-commerce systems [13].

The paper is organized as follows:

Section 2 will describe an extended transaction model that provides approximated ACID properties. Section 3 describes a general transaction pattern (algorithm) for implementing the approximated atomicity property. In this section, we will also illustrate by examples how to implement the approximated atomicity property in practice. Concluding remarks are presented in section 4.

*Related Research:* The transaction model described in section 2 is *The Countermeasure Transaction Model* [1]. This model owes many of its properties to e.g. Garcia-Molina and Salem [2], Mehrotra [3], Weikum and Schek [4] and Zhang [5]. Frank and Zahle [1] describe in detail the countermeasures used against the isolation anomalies in the E-commerce examples of section 3.

An early version of the pattern described in this paper has been developed for atomicity implementation in CSCW systems [14].

## 2. The Transaction Model

A *multidatabase* is a union of local autonomous databases. *Global transactions* [7] access data located in more than one local database. In recent years, many transaction models have been designed in order to integrate local databases without using a distributed DBMS. The countermeasure transaction model [1], has, among other things, selected and integrated properties from these transaction models in order to reduce the problems of the missing ACID properties in a distributed database not managed by a distributed DBMS. In The Countermeasure Transaction Model, a global transaction

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consists of a *root transaction* (client transaction) and several single site *subtransactions* (server transactions). The subtransactions can be nested transactions; i.e. a subtransaction may be a *parent transaction* for other subtransactions.

All communication with the user is managed from the root transaction, and all data is accessed through subtransactions. A subtransaction is either an execution of a *stored procedure* that automatically returns control to the parent transaction or an execution of a *stored program* that does not return control to the parent transaction.

All remote subtransactions are accessed through one of the following types of tools:

#### *Remote Call (RC)*

From a programmer's point of view, a RC functions like a remote procedure call or submission of a SQL query. RCs have the following properties, which are important from a performance and an atomicity point of view:

- If a parent transaction executes several RCs, the corresponding subtransactions are executed one at a time.
- A stored procedure or SQL submission has only local ACID properties.
- The stored procedure or SQL submission can automatically return control to the parent transaction.

#### *Update Propagation (UP)*

In this context, UP is used in the general sense of propagation of any update (not just replicas). The UP tool works in the following way:

The parent transaction makes the UP "call" by storing a so-called *transaction record* in persistent storage at the parent location. The following information must be stored in the transaction record:

The parent transaction id, the id of the subtransaction, the id of the location where the subtransaction should be executed, the id of a stored procedure (or the SQL code) and the parameters of the subtransaction.

If the parent transaction fails, the transaction record will be rolled back, and consequently the subtransaction will not be executed. When the parent transaction is committed, the transaction record is secured in persistent storage, and we say that the UP has been *initiated*. After the initiation of the UP, the transaction record will be read and sent by the UP tool to the location where the subtransaction should be executed. UPs may be implemented by using either push or pull technology as described in Frank and Zahle [1]. UPs have the following properties, which are important from a performance and an atomicity point of view:

- If a parent transaction initiates several UPs, the corresponding subtransactions may be executed in parallel.

- A subtransaction initiated from a UP has atomicity together with the parent transaction, i.e. either both are executed or none are.
- A subtransaction does not automatically return control to the parent transaction.

In the following, we will give a broad outline of how approximated ACID properties are implemented in the Countermeasure Transaction Model.

## 2.1 The Atomicity Property

An updating transaction has the *atomicity property* and is called *atomic* if either all or none of its updates are executed. In The Countermeasure Transaction Model, the global transaction is partitioned into the following types of subtransactions that are executed in different locations:

- The *pivot* subtransaction that manages the atomicity of the global transaction, i.e. the global transaction is committed when the pivot subtransaction is committed locally. If the pivot subtransaction aborts, all the updates of the other subtransactions must be compensated or not be executed.
- The *compensatable* subtransactions that all may be compensated. Compensatable subtransactions must always be executed before the pivot subtransaction is executed to make it possible to compensate them if the pivot subtransaction cannot be committed. Compensation is achieved by executing a *compensating* subtransaction.
- The *reliable* subtransactions that are designed in such a way that the execution is guaranteed to commit locally (sooner or later) if the pivot subtransaction is committed. A UP tool is used to automatically resubmit the request for execution until the subtransaction has been committed locally, i.e. the UP tool is used to force the reliable subtransaction to be executed.

The global atomicity of the pivot transaction models is implemented by executing compensatable, pivot and reliable subtransactions in that order.

RCs can be used to call/start the compensatable subtransactions and/or a pivot subtransaction, because the execution of these subtransactions is not mandatory from a global atomicity point of view. (If any problems occur before the pivot commit, we can compensate the first part of the global transaction).

After the commit decision of the global transaction, all the remaining updates are mandatory. Therefore, UPs are always used to execute the reliable subtransactions, which are always executed after the global commitment.

If the pivot fails or cannot be executed, the execution of all the compensating subtransactions are mandatory. Therefore, UPs are always used to execute the reliable compensating subtransactions.

### Example 2.1

Let us suppose that an amount of money is to be moved from an account in one location to an account

in another location. In such a case, the global transaction may be designed as a root transaction that calls a compensatable withdrawal subtransaction and a retrievable deposit subtransaction. Since there is no inherent pivot subtransaction, the withdrawal subtransaction may be chosen as pivot. In other words, the root transaction executed at the user's PC may call a pivot subtransaction executed at the bank of the user, which has a UP that "initiates" the retrievable deposit subtransaction. If the pivot withdrawal is committed, the retrievable deposit subtransaction will automatically be executed and committed later. If the pivot subtransaction fails, the pivot subtransaction will be backed out by the local DBMS. In such a situation, the retrievable deposit subtransaction will not be executed.

In our transaction model, subtransactions may be nested, i.e. a subtransaction may call another subtransaction, etc. In *The Open Nested Transaction Model* [4], the subtransactions of a compensatable subtransaction must be compensatable. (Otherwise, the parent transaction cannot be compensatable). This idea has been generalized and integrated into our transaction model in the following way:

- Subtransactions of a compensatable subtransaction must be compensatable. Please notice that sometimes the subtransactions of a compensatable subtransaction may also be designed as retrievable, which simplifies the application program and reduces the response time.
- Subtransactions of a retrievable subtransaction must also be retrievable. (Otherwise, the parent transaction cannot be retrievable).
- Subtransactions of a pivot subtransaction must either be compensatable or retrievable. Compensatable subtransactions must be executed before the commit of the pivot subtransaction and retrievable subtransactions must be executed after the commit of the pivot subtransaction.

Furthermore, a non-committed transaction should be subject to changes. This implies that a retrievable subtransaction, which more or less compensates a compensatable subtransaction, may be executed before the commit of the pivot subtransaction.

## 2.2 The Consistency Property

A database is *consistent* if the data in the database obeys the consistency rules of the database. If the database is consistent both when a transaction starts and when it has been completed and committed, the execution has the *consistency property*. Transaction *Consistency rules* may be implemented as a control program that rejects the commitment of transactions, which do not obey the consistency rules.

The definition above of the consistency property is not useful in multidatabases with approximated ACID properties because such a database is normally always inconsistent. However, a distributed database with

approximated ACID properties should have *asymptotic consistency*, i.e. the database should converge towards a consistent state when all active transactions have been committed/compensated. Therefore, in distributed databases with approximated ACID properties, we want the following property:

If the database is asymptotically consistent when a transaction starts and also when the transaction is committed, the execution has the *approximated consistency property*.

Frank [10] has described how to make a consistent database state for datawarehousing on top of a distributed database with approximated ACID properties.

## 2.3 The Isolation Property

A transaction is executed in *isolation* if the updates of the transaction only are seen by other transactions after the updates of the transaction have been committed.

If the atomicity property is implemented, but there is no global concurrency control, the following isolation anomalies may occur [7] [8]:

- *The lost update anomaly* is by definition a situation where a first transaction reads a record for update without using locks. After this, the record is updated by another transaction. Later, the update is overwritten by the first transaction. In the countermeasure transaction model the lost update anomaly may be prevented, if the first transaction reads and updates the record in the same subtransaction using local ACID properties. Unfortunately, the read and the update are often executed in different subtransactions, as we do not recommend locking a record across a dialog with the user. Therefore, it is possible for a second transaction to update the record between the read and the update of the first transaction.
- *The dirty read anomaly* is by definition a situation where a first transaction updates a record without committing the update. After this, a second transaction reads the record. Later, the first update is aborted (or committed); i.e. the second transaction may have read a non-existing version of the record. In our transaction model this may happen when the first transaction updates a record by using a compensatable subtransaction and later aborts the update by using a compensating subtransaction. If a second transaction reads the record before it is compensated, the data read will be "dirty".
- *The non-repeatable read anomaly* or *fuzzy read* is by definition a situation where a first transaction reads a record without using *long duration locks* [7]. This record is later updated and committed by a second transaction before the first transaction is committed or aborted. In other words, we cannot rely on what we have read. In our transaction model this may happen when the first transaction reads a record that is updated by a second

transaction, which commits the record locally before the first transaction commits globally.

- *The phantom anomaly* is not relevant in this paper.

In the following, we will only describe the countermeasures that are used in the e-commerce examples of section 3. We will first describe a countermeasure against the lost update anomaly, because it is the most important anomaly to guard against.

#### *The Commutative Updates Countermeasure*

Adding and subtracting an amount from an account are examples of commutative updates. If a subtransaction only has commutative updates, it may be designed as commutable with other subtransactions that only have commutative updates. This is a very important countermeasure, because retrievable subtransactions have to be commutable in order to prevent the lost update anomaly.

#### **Example 2.2**

A deposit may be designed as a retrievable commutative subtransaction, where the subtransaction reads the old balance of the account by using a local exclusive lock, adds the deposit to the balance and rewrites the account record. After this the retrievable commutative subtransaction will commit locally. This deposit subtransaction is commutable with other deposit and withdrawal subtransactions.

#### *The Pessimistic View Countermeasure*

It is sometimes possible to reduce or eliminate the dirty read anomaly and/or the non-repeatable read anomaly by giving the users a pessimistic view of the situation. The purpose is to eliminate the risk involved in using data where long duration locks should have been used. A pessimistic view countermeasure may be implemented by using:

- Compensatable subtransactions for updates which limit the options of the users.
- Retriable subtransactions for updates which increase the options of the users.

#### **Example 2.3**

When updating stocks, accounts, vacant passenger capacity, etc. it is possible to reduce the risk of reading stock values that are not available ("dirty" or "non-repeatable" data). These pessimistic stock values will automatically be obtained if the transactions updating the stocks are designed in such a way that compensatable subtransactions (or the pivot transaction) are used to reduce the stocks and retrievable subtransactions (or the pivot transaction) are used to increase the stocks.

### **2.4 The Durability Property**

The execution of a transaction has the durability property, if the updates of a transaction cannot be lost after the

transaction has been committed. The updates of transactions are said to be *durable* if they are stored in stable storage and secured by a log recovery system. In case a global transaction has the atomicity property (or approximated atomicity), the global durability property (or approximated durability property) will automatically be implemented, as it is ensured by the log-system of the local DBMS systems [9].

### **3. A Transaction Pattern for Atomicity Implementation**

In this section, we will describe a general transaction pattern that can simplify the atomicity implementation. In order to implement the atomicity property, the transaction pattern must follow the rules of our nested transaction model described in section 2. After the presentation of the transaction pattern, examples will illustrate how to use the transaction pattern.

The following figure illustrates a UML statechart diagram for a global transaction. The syntax for a transition has tree parts, all of which are optional: *Event* [*Guard*] / *Action*. In the diagram, all the events are either subtransactions submitted by the user or subtransaction aborts. All the event actions and state activities of the diagram must be designed with "subtransaction atomicity". In the diagram, we do not deal with subtransaction aborts that do not change the state of the global transaction, because the user without problems can resubmit these subtransactions. All the event guards coming from the same state in the diagram are mutually exclusive, and, therefore, the diagram does not have loose ends.

The description of the event actions and state activities is a pattern without application logic, i.e., only the necessary database access types of the actions/activities are described. It is important to distinguish between two types of locations for each subtransaction:

- The "execution location" is the location where a subtransaction is executed. For example, the "root location" is the execution location of the root transaction, and it is normally the user's PC. The "pivot location" is the location where the pivot subtransaction is executed.
- A "log location" is the location where the parameters of a subtransaction are stored. If an event corresponding to a subtransaction changes the state of the global transaction, the new state is also stored in the log location.

Often, the log location of a subtransaction is not the same as the execution location, and, in such a situation, it is important to make the updates in the two locations atomic (or approximated atomic). Otherwise, recovery will be much more complex.

If a subtransaction fails and/or the user does not get an answer, it is important for the user to know the state of

the global transaction. Therefore, a State record must first be created in the log location of the root transaction. Later, a new State record is created in the log location of the compensating subtransactions, and finally, a State

record is created in the log location of the pivot subtransaction. By reading these State records it is always possible to find the state of the global transaction.

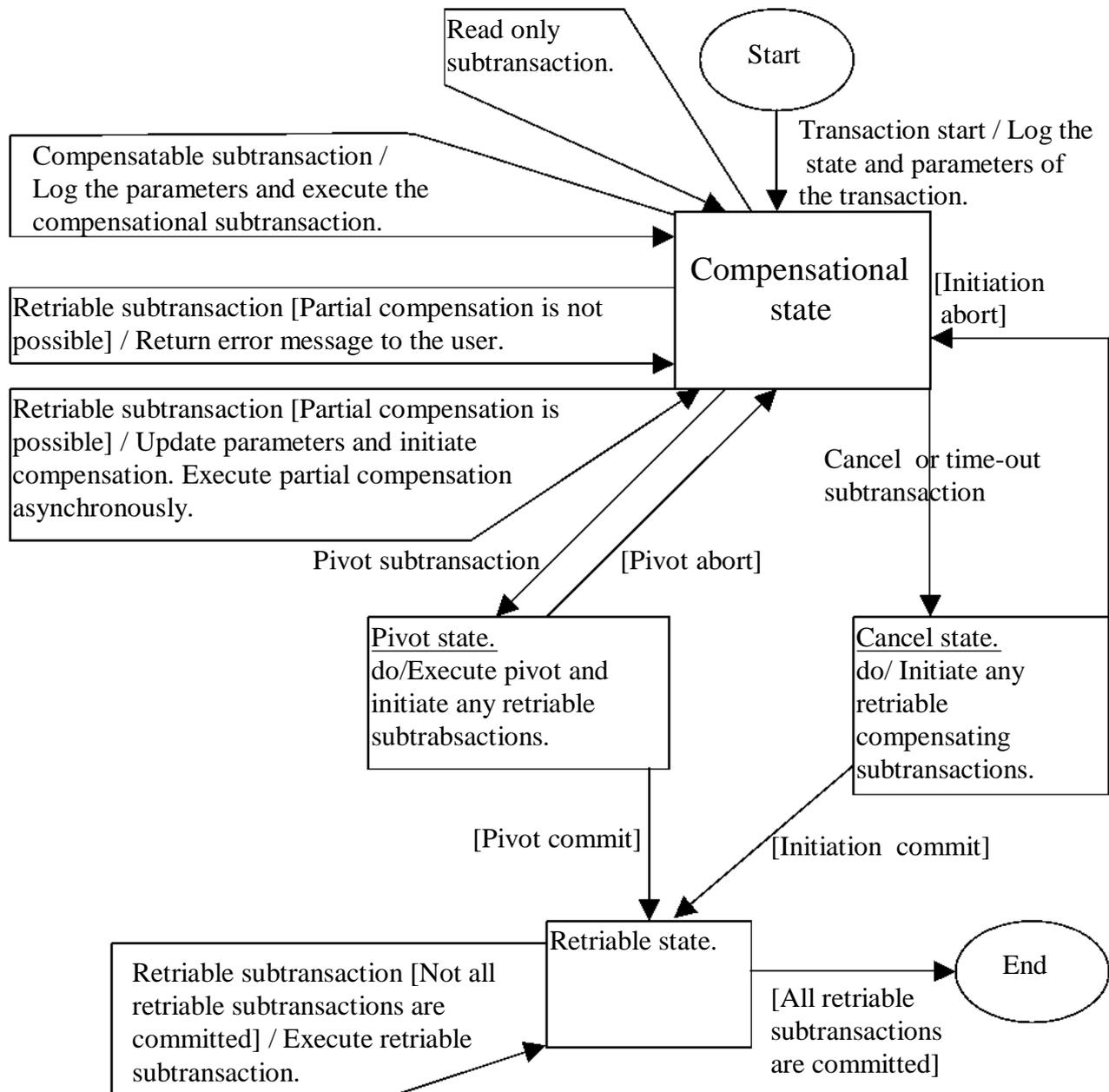


Figure 3.1. Statechart diagram for a general global transaction.

In the following, we will illustrate how to use our nested transaction model in E-commerce systems. The first example outlines how business-to-business E-commerce transactions may be designed by using our transaction model. The second example describes a more complex business-to-consumer E-commerce transaction.

In contrast to the business-to-consumer segment, business-to-business E-commerce may anticipate trust between the customer and seller. Hence, global transactions need not involve a third party, such as the

bank of the customer or seller. This simplifies the global transaction in Example 3.1 compared to Example 3.2, which describes the global transaction of a retail customer.

### Example 3.1

In this example of business-to-business E-commerce, we will assume that the seller has a customer file with the names, addresses, account balances and credit limits for all his customers. Therefore, the banks of the customers

are not involved in the following description of the order transaction. In this example, we choose the local server of the seller as both pivot location and log location for all the subtransactions. The root location is the user's local PC. Other locations are any remote stock servers of the seller.

At first, the customer reads the offers made by the seller. If the customer wants to make an order, the root transaction in the location of the customer calls a compensatable subtransaction at the location of the seller. This subtransaction creates an order record with relationship to the customer record at the same location. A new State record with the value "Compensatable state" is created for the transaction. Now, the customer can make order-lines. For each new order-line made by the customer, the root transaction starts a compensatable subtransaction, and this subtransaction creates an order-line at the location of the seller. For each order-line, a compensatable sub-subtransaction updates the local (or remote) stock of the product ordered in the order-line. If the first stock cannot fulfill the quantity ordered in the order-line, another stock may be accessed by using another compensatable sub-subtransaction. If an order-line cannot be fulfilled, the field "quantity-delivered" in the order-line is updated. Please notice that only *short duration locks* are used, and, therefore, distributed deadlock cannot occur. When the order form has been completed, the pivot subtransaction is executed at the location of the seller where it updates the account balance of the customer. If the credit limit of the customer is not violated, the pivot subtransaction initiates a retrievable sub-subtransaction that is sent to the customer to confirm the deal. The pivot subtransaction also changes the State record to "Retriable state" before all the updates are committed. Alternatively, the global transaction will be rejected or the customer asked to reduce the amount of the balance in order to avoid violating the credit limit.

By executing a retrievable subtransaction that reduces the quantity ordered in an order-line, the amount in the order-line may be reduced. For each reduced order-line, a retrievable sub-subtransaction increases the local (or remote) stock of the product that is reduced in the modified order-line. Finally, the customer can retry to execute the pivot subtransaction.

### Example 3.2

In this example, we will describe the atomicity implementation of a business-to-consumer E-commerce transaction where the global transaction also involves the banks of the customers and the seller. In the example, the bank of the customer is used as the pivot location. The server of the seller is the log location of all the subtransactions. The PC of the user is the root location. When the retail customer wants to make an order, the first compensatable part of the global transaction may be the same as in the previous example, where the order and order-lines were created. However, the seller may not know the customer, and, therefore, a compensatable customer record should also be established. Before the pivot subtransaction is executed, the balance of the

customer is updated by a compensatable subtransaction and the State record changed to "Pivot state". The pivot subtransaction is executed at the bank of the customer, where payment of the customer may be accepted/committed and a retrievable subtransaction to the seller initiated. When the retrievable subtransaction of the pivot is received in the location of the seller, the State record of the global transaction is changed to "Retriable state", and the account of the customer updated. A retrievable sub-subtransaction may also be initiated in order to confirm the deal for the customer.

## 4. Conclusions

Normally, distributed systems do not have the traditional ACID properties because they will reduce availability and write performance. In this paper, we recommend using approximated ACID properties, i.e. from an application point of view the system should function as if all the traditional ACID properties had been implemented.

The distributed approximated atomicity property manages the workflow of a distributed transaction in such a way that either all the updates of the transaction are executed (sooner or later) or all the updates of the transaction are removed/compensated. In this paper, we have described in detail how distributed approximated atomicity may be implemented. That is, we have described a nested transaction pattern (algorithm) designed for updating multidatabases with approximated atomicity. The transaction pattern can be used for all types of distributed updates, and, therefore, it may reduce time for design and programming. Our transaction pattern makes it possible to nest all types of subtransactions to any depth. In addition, the root location (normally the PC of the user), the log location (the location where the recovery information is stored) and the pivot location (the location where the global transaction is committed) may be different locations or grouped in any combination. Another feature is that our transaction pattern allows retrievable subtransactions to be executed before the global commit if the retrievable subtransactions more or less compensate compensatable subtransactions that have already been committed locally but not globally.

We have illustrated how to use the transaction pattern in E-commerce systems. For example, if one of the partaking subsystems fails in a system for E-commerce, the approximated atomicity property will ensure that when an order is accepted (the global commit), the stock levels, payment etc., are managed automatically in the locations of the partaking product stocks and banks. Even logistics and/or production workflow may be managed by using approximated atomicity.

We have cooperated with one of the major ERP software companies in designing a distributed version of the ERP system with local autonomous databases in the different sales and stock locations.

## References

- [1] L. Frank and T. Zahle, 'Semantic ACID Properties in Multidatabases Using Remote Procedure Calls and Update Propagations', *Software - Practice & Experience*, 1998, 28, pp77-98.
- [2] H. Garcia-Molina and K. Salem, 'Sagas', *ACM SIGMOD Conf*, 1987, pp 249-259.
- [3] S. Mehrotra, R. Rastogi, H. Korth and A. Silberschatz, 'A Transaction Model for Multidatabase Systems', *Proc International Conference on Distributed Computing Systems*, 1992, pp 56-63.
- [4] G. Weikum and H. J. Schek, 'Concepts and Applications of Multilevel Transactions and Open Nested Transactions', *A. Elmagarmid (ed.): Database Transaction Models for Advanced Applications*, Morgan Kaufmann, 1992, pp 515-553.
- [5] A. Zhang, M. Nodine, B. Bhargava and O. Bukhres, 'Ensuring Relaxed Atomicity for Flexible Transactions in Multidatabase Systems', *Proc ACM SIGMOD Conf*, 1994, pp 67-78.
- [6] L. Frank, 'Integration of Different Commit/Isolation Protocols in CSCW Systems with Shared Data', *Perspectives of System Informatics, Third International Andrei Ershov Memorial Conference, PSI'99*, Springer-Verlag, pp 341-351.
- [7] J. Gray and A. Reuter, *Transaction Processing*, Morgan Kaufman, 1993.
- [8] H. Berenson and P. Bernstein, J. Gray, J. Melton, E. O'Neil and P. O'Neil, 'A Critique of ANSI SQL Isolation Levels', *Proc ACM SIGMOD Conf*, 1995, pp 1-10.
- [9] Y. Breitbart, H. Garcia-Molina and A. Silberschatz, 'Overview of Multidatabase Transaction Management', *VLDB Journal*, 2, 1992 pp 181-239.
- [10] L. Frank, 'Integrity Problems in Distributed Accounting Systems with Semantic ACID Properties', *Proc. Third Annual IFIP TC-11 WG 11.5 Working Conference: Integrity and Internal Control in INF Systems*, Amsterdam, The Netherlands, November 18-19, 1999.
- [11] L. Frank, 'Evaluation of the Basic Remote Backup and Replication Methods for High Availability Databases', *Software - Practice & Experience*, Vol. 29, issue 15, 1999, pp 1339-1353.
- [12] Wil van der Aalst, Process-Oriented Architectures for Electronic Commerce and Interorganizational Workflow, *Information Systems*, Vol. 24, No. 8, pp. 6399-671, 1999.
- [13] V. Zwass, Electronic commerce: structures and issues, *International Journal of Electronic Commerce*, Vol. 1, No. 1, pp. 3-23, 1996.
- [14] L. Frank, 'Atomicity Implementation in Cooperative Distributed Systems With High Performance and Availability', *Proc of Collaborative Technology Symposium 2002*, January 2002.

# English as the Infrastructure Language for a Multilingual Internet

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## Abstract

English has been the dominant language of the Internet for users and infrastructure development. This is changing due to the increasing number of non-English speaking Internet users. While the Internet community will eventually become a multilingual environment; the development of the Internet infrastructure source will still be English. This will have an impact on global businesses and government's education systems in non-English speaking countries. Eventually, English will be the global language for Internet developers and professionals of global businesses.

## 1. Introduction

In 1999, less than 10% of the world's populations spoke English as their primary language. The majority (56.5%) of Web users use English as the language of choice [4]. This is changing. Global Reach has indicated that one half of Internet users are from non-English speaking nations. By 2003, this will reach 70%. The majority of Web page content will be in languages other than English [11]. There is more and more evidence of the adoption of non-English use of the Internet. Evidence of this growing trend are the emergence of translation services, multilingual domain names, Unicode, and the use of icons [17]. It is clear that Web pages are becoming multilingual for users and business customers. However, the infrastructure and Internet development are still in English. This is due to the need for global standards in programming and technical communication.

## 2. The English Internet

The Internet began with ARPANET, a research project by the U.S. Department of Defense, to allow military computers to communicate through dynamic paths of communications. If one path failed, another path was used. Later the U.S. government divided this network into a military subsystem and a civilian subsystem. It was the civilian network that became today's Internet. In 1992, the U.S. government allowed businesses to link to the Internet. [16, p. 243]

The character set used by this new network was American Standard Code for Information Interchange (ASCII). This has been the coding scheme for computer communication. Like the Internet, it too originated in the United States. The text characters used consisted of the English alphabet. E-mail and web page source code use

this character set.

As expected, since the development of the Internet originated in an English speaking country, the technical infrastructure and web pages (interface for users) all have used English. English has been the lingua franca of the Internet [15].

## 3. Need for Multilingual Web Pages for Customers

The Internet has created one global market. Those who understand the technical and cultural issues have a head start on capturing new audiences and helping their businesses forge a worldwide market [22]. There is a need for a multilingual Web. By having Web sites in local languages, more businesses and opportunities can be established. People are more comfortable with e-commerce when the product is in their native language [24], even if English is their second language. Those companies that only have English version of their Web sites or just their local language versions stand to lose their existing or potential international clients to their competitors who communicate in the native language of the customer [17].

Several Information Technology trade periodicals indicate that English has been the dominant language on the Internet and most of the revenue generated inside the U.S.A. However, this is changing. The Internet is moving from English to multilingual [7][5][14][20][22][25][26][29]. For example, English is a second language in Thailand. However, Thai language content web is increasing [6]. The use of the Internet has become more and more popular among non-English speaker, especially for people in the countries like Japan, Germany, China, and Korea [21].

Companies have awakened to that trend of the Internet becoming multilingual and are developing country-specific and language-specific Web sites for individual markets [12]. Some examples of these corporations are IBM, Gap, McDonald, VISA, and Coca-Cola. International firms such as Sony, Mercedes Benz, Kodak are very international focused as well [17]. For global businesses to be successful, they have to become multilingual [2]. The localization of the Web culturally, geographically, and linguistically is a trend that will continue [20]. The result will be non-English speakers occupying more than half of all Web traffic in

their respective native languages [21]. English will NOT be the online lingua franca for long [1].

#### 4. The Multilingual Internet

The Internet is moving to multilingual web sites. This is due to web page text written in the native language. The result of having the Web sites written in the users' native language brings a sense of familiarity that helps bridge the language gap [17]. To facilitate this, a new coding scheme for the user interface had to be developed.

ASCII is the coding scheme of the Internet. ASCII, American Standard Code for Information Interchange, was defined by the American National Standards Institute (ANSI) in the United States and by the International Organization for Standardization (ISO) worldwide [10]. The character set consists of the English alphabet. To resolve this limited character set, Unicode was developed. It is a multi-byte character representations system for computers, and provides for the encoding/exchanging of all the text of the world's languages [3]. Unicode uses 16 bits, which means that it can represent more than 65,000 unique characters [23]. Unicode allows programmers to provide software that ordinary people can use in their native language" [3]. Unicode is a character coding system designed to provide the ability to display text of the world's languages on web pages.

Internet users want domain names in their native language instead of today's English-language domain names. Unicode can also be used for domain names. This would require no changes to the DNS protocol or servers [13]. Multilingual domain name is still under implementation because the languages other than English do not use ASCII-based characters. There are several organizations working toward solution to implement non-English domain names on the Web [17]. The current solution involves converting foreign language characters into Unicode. Then encoding them in ASCII for transmission over the Internet as is currently done. It creates a presentation layer to display domain names to end users in their native languages [28].

#### 5. English as the Source Language for Multilingual Web Pages

A web page consists of two parts: text content and source code. Text content is the text displayed on the web page. Unicode is used here to display the different characters of the variety of world languages. Examples of source code components are XML, Java, JavaScript, and HTML. By dividing the web page into these two parts, a company can extract all language and cultural specific elements, making the source code language-neutral and easily tailored for a local language by adding translations of text messages, icons, and cultural data. Hence, the web page is easily made multilingual.

Such a web page is able to run with any localized text content, without requiring source code changes or recompilation. It is this source code that incorporates

English into the infrastructure. Web developers write English "source code" to support multilingual web page "content." When you view the source code for any multilingual web page, the HTML, XML, Java, and JavaScript are in English.

Such software allows web pages for multilingual users to display the text in the correct local language and character set. For example, XML uses Unicode by default, which allows end users to encode text in their preferred language and character set [18].

Because ASCII is used by the Internet, the domain names are also in English. As stated earlier, the user interface will use Unicode, making domain name services multilingual. However, as noted, the Unicode domain names from the user interface will be changed to the English version of ASCII.

Considering the source code and domain names, English will continue to remain the most widely used language in the technical arena of the Internet.

#### 6. English as the Global Language for Internet and other Information Systems Professionals

The language used at international Internet conferences and by international Internet journals is English. Table 1 shows some of the Internet related conferences for the year 2002. Research papers, Proceedings, official web site, and/or language of these conferences used English, and in some cases, along with the host country's native language. Table 2 shows some of the international journals relating to the Internet that are also in English.

#### 7. Implications for Governments and Global Businesses

What appears to be developing on the Internet, as far as spoken languages are concern, is a distinction between local and global languages. The Internet will be multilingual due cultural pride and that people are more comfortable with e-commerce when the product is in their native language [24]. Local web interfaces will be in the local language. This includes operating systems and web development tools. Sun's Solaris 7 operating system is a fully internationalized. It uses a single global binary that allows for the use of different language versions [19]. Microsoft, IBM, and Sun are also developing their software systems in multi-languages [9].

When dealing on a global scale, there has to be a common language for all to understand. English is the language of international commerce/business and science [8][15][27]. European businesses are making English their official language. Companies are looking at the whole continent as their domestic market. [8]. English is becoming the common language for a multilingual continent. It appears that global developers and global users of the web are following this trend. To be able to

function on a Global/International scale via the Internet, Internet professionals and business executives will have English as a second language.

Table 1. Internet related conferences for the year 2002

<p>15th Bled Electronic Commerce Conference eReality: Constructing the eEconomy  <a href="#">Bled, Slovenia</a>, June 17 - 19, 2002.</p> <p>7<sup>th</sup> Association Information Management Conference to be held in Hammamet, Tunisia, May 30 to June 1, 2002.</p> <p>2<sup>nd</sup> International Conference on Electronic Business (ICEB 2002), Taipei, Taiwan, Dec 10-13, 2002.</p> <p><a href="#">The 7th Asia Pacific Decision Sciences Institute (APDSI) Annual Meeting</a>, Bangkok, Thailand, 24-27 July, 2002.</p> <p>The 3rd International Conference On Web Information Systems Engineering (WISE 2002): 12-14th Dec 2002, Singapore.</p> <p><a href="#">The International Conference on Information Technology, Communications &amp; Development</a>, Kathmandu, Nepal, 1-3 December 2002.</p> <p><a href="#">11th European Conference on Information Systems</a>, Naples, Italy, 19-21 June, 2003.</p> <p><a href="#">The First International Conference on Information and Management Sciences</a>, Xi'An, China, 24-28 May, 2002.</p> <p><a href="#">Internet &amp; Investments Forum</a>, St. Petersburg, Russia, 25-26 April 2002</p> <p><a href="#">Second International Workshop on Electronic Commerce (WELCOM'01)</a>, Heidelberg, Germany, 16-17 November, 2001.</p> <p>Global IPv6 Summit in Korea July 11-12, 2002, Seoul, Korea.</p>
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Table 2. International Journals relating to the Internet

<p>Internet Research, MCB University Press, UK</p> <p>International Journal of Electronic Business, Inderscience Publications, UK</p> <p>International Journal of Internet and Enterprise Management, Inderscience Pub., UK</p> <p>Journal of Global Information Management, Idea Group Publishing, USA</p> <p>The International Journal of Information Systems Applications, Elsevier Science, USA</p>
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The impact is that computer curriculum in non-English speaking countries will have to incorporate English. Global businesses will have to provide English training to their international computer personnel.

## 8. Conclusion

The majority of Web page content will be in languages other than English [11]. Evidence of this growing trend can be seen through the emergence of the tools such as translation services, multilingual domain names, Unicode, and the use of icons [17]. It is clear that Web pages are becoming multilingual for users and business customers. However, the global infrastructure of the Internet will still in English because of the need for global standards in programming and technical communication. English will be the global language for Internet developers and global businesses professionals.

## References

- [1] Dornan, A. (1999). The Power of Babel. Data Communications, 28(12) p.14.
- [2] Baker, S. (2001). A net Not Made in America. Business Week, 3725:124.
- [3] Burger, T. W. (2001). Linux Unicode programming: How to incorporate and utilize Unicode for foreign language support. <http://www-106.ibm.com/developerwork/linux/library/1-linumi.html>. Downloaded on 6/11/2002.
- [4] Castelluccio, M. (1999) Hey, Can Anybody Read This? Management Accounting, 81(1) July, pp.63-64.
- [5] Chapin, D. (2000). Going Global via the Web? Don't trip. McTechnology Marketing Intelligence, 20(11), pp. 54-58.
- [6] Crispin, S. W. (2000). Local Lingo. Far Eastern Economic Review, 163(18), p 43.
- [7] Dornan, A. (1999). The Power of Babel. Data Communications, 28(12), pp. 14.
- [8] Fox, J. (2000). The Triumph of English. Fortune, 142(6), pp. 209-212.
- [9] Gantz, J. (1998). Coming soon: Language Barriers. Computerworld, 32(5), p. 33.
- [10] Gilbert, H. (1999) Understanding Data Communications, 6<sup>th</sup> ed. New Riders, Indianapolis.
- [11] Glaeser, C. (2000) Local Heroes. Bank Systems & Technology, 37(10) October, S5, S17.
- [12] Gray, R. (2000). Make the most of the Local Difference. Marketing, 27-28.
- [13] Marsan, C. D. (2001). Patent flap slows multilingual domain name plan. Network World, 18(13), pp. 9,30.
- [14] MacLeod, M. (2000). Language Barriers. Supply Management 5(14), pp. 37-38.
- [15] McCune, J. C. (1999). English written here. Management Review, 88(2), p. 12.
- [16] Oz, E. (2000). Management Information Systems, 2<sup>nd</sup> Ed. Course Technology - Thomas Learning, Cambridge, Ma.
- [17] Padunchwit, P. and White, G. (2001). From English to Multilingual on the Internet. Proceedings of the 33<sup>rd</sup> Annual Conference of the Southwest Decision Sciences Conference, St. Louis, Mo. November, 2001.
- [18] Schloss, W. (2000). Ten best bets for XML applications. <http://www-106.ibm.com/developerwork/library/tenxmlapps/>. Accessed on 6/11/2002.
- [19] Sun Microsystems (1998). Solaris 7 Globalization

- Technology Overview: Product Brief. Sun Microsystems, Inc. Palo Alto, California.
- [20] Taylor, C. (2000). The Language of the Web. Far Eastern Economic Review, 163(49), pp. 68-69.
- [21] Tweney, D. (1999) Increasingly Global, the Web Challenges U.S.-Based Companies. Infoworld, 21(29) July, p.52.
- [22] Ulfelder, S. (2000). All the Web's a Stage. CIO, 14(1), pp. 132-142.
- [23] Unicode, Inc. (2001) What is Unicode, Available from: <http://unicode.org/unicode/standard/WhatIsUnicode.html>. Accessed 29 April, 2001.
- [24] Wah, L. (1998). Online subscribers booming among non-English speakers. Management Review, 87(6), p.7.
- [25] Wilhelm, K. (2001). Tongue-tied on the Net. Far Eastern Economic Review, 164(7), pp.38-40.
- [26] Wonnacott, L. (2001). Going Global may bring New Opportunities for Existing Customers. Inforworld, 23(14), pp 58.
- [27] Woodward, N. H. (1999). Do you speak Internet? HR Magazine, 44(4), pp. s12-s16.
- [28] Yamada, M. (2000) Tackling the Web's Language Barrier, Available from: <http://www.cnn.com/2000/tech/computing/07/14/icann.language.idg/index.html>. Access 20 April, 2001.
- [29] Yunker, J. (2000). Going Global. Pharmaceutical Executive, 20(7), pp. 138-146.

# Business Integration for the Hospital Medical History Database System by Using the Java Server Page and SQL Technique

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## Abstract

*This research not only describe convenience of e-business system but also point out the key techniques to construct Internet system of medical history related technique – JSP, SQL, JDBC, ODBC, Javascript, Oracle Database, Internet techniques and so on. The doctor and the staff who use this Internet system can access, delete, update, and modify the Internet database. Furthermore, they can download and upload images and documents via Internet. This system can garner the security and convenience when you use this system.*

**Keywords:** JAVA, JSP, JavaBean, Oracle Database, Servlet, JavaScript, Telemedicine, hospital's Internet and Intranet, medical image process via the Internet.

## 1. Introduction

The web server of jakata-tomcat [3,4] and the technique of JSP [4] implement this JSP Internet patient medical history database system. Also we connect the Internet Oracle database [6] with JDBC and ODBC [4] [5] [6] drivers to the JSP server. When you initially browse the JSP file, the JSP file will be compiled to the servlet file [3]. The servlet file is a byte code file, which can be executed in a more efficient way when a client demands this file. When client requests a demanded servlet, the servlet will be translated into HTML file in server and return this HTML file to client. Thus the client can only see traditional language of HTML; therefore the secret information can be hidden.

Since JSP was based on framework of JAVA [1], thus we suggest someone who wants to program the JSP language should had experiences in JAVA programming. Moreover, our technique not only includes server side issue, but also includes client side issue. We use component of HTML input-box and JAVASCRIPT [2] to simplify the

input process. Furthermore, JSP files another function is the JSP can include javabeen program code. The implementation concept of Javabeen is similar to active X. Using JSP has the following advantage: (1) JSP is a freeware language. (2) JSP can be executed in different platforms. (3) JSP is a faster language.

## 2. Access and Process the Patient's medical history by the Internet Technique

### 2.1 The doctor's login system



Figure 2.1.1: Doctor login and confirm page

Figure 2.1.1 shows when a doctor keys in the login ID and password and presses login button, the system will save the login ID and password in the session object automatically. Each time when doctor login to the system, the system will take login ID and password to check against the permit-account automatically. If he or she is the legal user, he or she then can login this system; otherwise, the system will cut the usage to the user. The Java Saver Pages is operating on the server side; in the client side, the client can't see the Java Server Pages source code. Thus the web server can hide information form the client.

### 2.2 Add a record to system

病歷號碼	e9002016	性別	男 <input type="radio"/> 女 <input type="radio"/>
病患姓名	陳秀美	電話	04-2234567
生日	1970/10/30	照片檔名	amy.jpg
職業	商業	學歷	大學
圖檔上傳	C:\MyDocument\amy.jpg <input type="button" value="瀏覽..."/>		

病歷號碼	性別	病患姓名	電話	生日
e9002001	男	曾建羸	04-7654321	1968/6/6
e9002013	男	黃宏楠	05-5998992	1974/1/21
e9002015	男	洪松男	04-7561019	1976/10/27
e9002016	女	陳秀美	04-2234567	1970/10/30

Figure 2.2.1: Add a new patient's record to the system

Figure 2.2.1 shows add a new patient's record to the system. The user can type in the necessary data and press the transmit button to send the typed message to the web server. By checking figure 2.2.1, one can find the following advantage:

1. Using HTML text-input-box can reduce mistakes and increase inputting efficiently. For example, we can use combo button to reduce times of input and increase efficiency.
2. For the client side, by using the java text-input-box one can prevent mistakes happened too. For example, when one user types the date-field with the wrong date-type, the system will give a warning to the user to avoid mistakes.
3. Javabeen can simplify the writing-process of JSP and reuse them. For example, in this case, when you have many files need to upload or download, you can use java bean to pack program and reuse them.

### 2.3 Delete a record from system

**Before**

病歷號碼	性別	病患姓名	電話	生日
e9002001	男	曾建羸	04-7654321	1968/6/6
e9002013	男	黃宏楠	05-5998992	1974/1/21
e9002015	男	洪松男	04-7561019	1976/10/27
e9002016	女	陳秀美	04-2234567	1970/10/30

病歷號碼

**After**

病歷號碼	性別	病患姓名	電話	生日
e9002001	男	曾建羸	04-7654321	1968/6/6
e9002015	男	洪松男	04-7561019	1976/10/27
e9002016	女	陳秀美	04-2234567	1970/10/30

Figure 2.2.1: Delete a patient's record from the system

Figure 2.2.1 shows that the user can input a patient number

that the user want to delete and press the enter button to delete a record from the system. The server will execute SQL command inside the server and delete the record. Although most machines implement the SQL command by SQL-92 protocol, but some components are not clear defined in this protocol. Thus each company has its dedicated rules to execute the SQL commands. Therefore you shall use oracle dedicated SQL command for oracle database.

### 2.4. Query a record from system

病歷號碼	文件代碼	圖片檔名(before)	圖片檔名(after)
e9002001	k6	e9002001b1.jpg	e9002001a1.jpg
e9002001	k5	e9002001b2.jpg	e9002001a2.jpg
e9002015	k9	e9002015b1.jpg	e9002015a1.jpg
e9002015	k10	e9002015b2.jpg	e9002015a2.jpg
e9002016	k7	e9002016b1.jpg	e9002016a1.jpg

病歷號碼  文件代碼

病歷號碼	病患姓名	手術前圖片	手術後圖片
e9002015	洪松男		

文件代碼 (下載)

Figure 2.4.1: query a patient's record from the system

Figure 2.4.1 shows the Java Server Page's Search function. One can input a patient number and press the search button to pick the patient data from the database and display the patient data in the Internet page.

### 2.5 Modify a record from system

Figure 2.5.1 shows the Java Server Page's update function. One can input a patient number and fill in the necessary data and press update button to update the data.

## 3. Results and conclusion

The technique of JSP and the server of Tomcat implement this Internet system. The patient can access, update, and delete information from the hospital mainframe computer by the JSP technique. Furthermore, the patient can even download and upload the files via the JSP technique. Since JSP is inherited from Java, JSP can be executed in different platform too. Each time when a JSP file is execute, an attached class-file will be compiled. If the same JSP page were executed again, the JSP file will not be compiled again. The server can simply execute the previous compiled class-file; thus, the execution speed will be faster.

By the usage of the reuse of the class-file, the efficiency of JSP can be superior to ASP. Furthermore, there are many web server support JSP and most of them are freeware.

## Reference

- [1] ZUKOWSKI,JOHN 原著,陳常侃 譯,“精通 JAVA 2:基礎篇”, 儒林圖書,2000
- [2] 陳會安,“JAVASCRIPT 網頁製作徹底研究”, 旗標,2001
- [3] Jason Hunter &William Crawford,“Java Servlet Programming 3<sup>RD</sup> EDITION”,O'REILLY,2002
- [4] 林邦傑,“JSP 程式設計”,知城數位,2000
- [5] Graham Hamiton and Rick Cattell and Maydene Fisher,“JDBC Database Access with Java”,Addison Wesley , 1998
- [6] Steve Bobrowski, “Oracle 8i for windows NT”,Mc GrawHill,2000

**Before**

病歷號碼	性別	病患姓名	電話	生日	照片檔
e9002001	男	曾建蕙	04-7654321	1968/6/6	e9002001.jp
e9002015	男	洪松男	04-7561019	1976/10/27	e9002015.jp
e9002016	女	陳秀美	04-2234567	1970/10/30	amy.jpg

**Update**

病歷號碼: e9002015

確定

病歷號碼	e9002015	性別	男
病患姓名	洪松男	電話	0913097999
生日	1976/10/27	照片檔名	e9002015.jpg
職業	工業	學歷	大學
圖檔上傳	瀏覽...		
生活習慣	抽煙 <input type="checkbox"/>	喝酒 <input type="checkbox"/>	吃檳榔 <input type="checkbox"/>
		熬夜 <input checked="" type="checkbox"/>	
	送出	重新設定	

**After**

病歷號碼	性別	病患姓名	電話	生日	照片檔
e9002001	男	曾建蕙	04-7654321	1968/6/6	e9002001.jp
e9002015	男	洪松男	0913097999	1976/10/27	e9002015.jp
e9002016	女	陳秀美	04-2234567	1970/10/30	amy.jpg

Figure 2.5.1: Update a patient's record

# Assessing the Impact of Internet Adoption Levels on Competitive Advantage

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## Abstract

This paper introduces a model for Internet adoption, namely: level 0 – e-mail adoption; level 1 – Web presence; level 2 – prospecting; level 3 – business integration; and level 4 – business transformation. Two broad Web site categories can be identified: informational Web site and transactional Web site. The competitive advantages in terms of differentiation, cost reduction, innovation, growth, and alliance that are affected by Internet adoption are examined.

A questionnaire survey of 553 firms was conducted, of which 159 usable responses were received, resulting in an effective response rate of 28.8%. The results show that proactive business strategy, firm size and competitive advantage are found to be positively related to Web adoption level. Implications of the results for researchers and practitioners are discussed, and directions for future research are proposed.

## 1. Introduction

In this decade, the Internet has become a new profit-enhancing tool for firms, and the adoption of Internet technology is especially important for firms if they are to do business on the Internet. However, there is a paradox in this mode of profit-enhancement since Internet adoption itself does not necessarily lead to financial growth. The role of Internet Web technology is more like a long-term strategic tool than a short-term profit generator. To what extent should firms adopt the Internet? How could Internet adoption enhance firms' competitive ability? These are the research questions that this paper attempts to answer.

## 2. Model for Internet Adoption

An extensive literature review is conducted pertaining to research streams on Internet-based commerce, technology adoption, and competitive advantage. A model of Internet adoption is proposed, namely: level 0 – e-mail adoption; level 1 – Web presence; level 2 – prospecting; level 3 – business integration; and level 4 – business transformation.

**Level 0 – No Web Site, Only E-mail Account:** A firm at adoption level 0 is one that has an e-mail account but does not have a Web site. The term "level 0" is used because the firm has not actually adopted the Web. The inclusion of level 0 is based on research done by Teo et al.

[8]. They classified Internet adoption into three groups: non-adopters (those without Internet account), adopters without Web sites but with Internet account, and adopters with Web sites. Through an extensive examination of Web sites in Singapore, we found that some firms do not have independent domain names and Web sites. These firms normally have an Internet e-mail account that they use to establish connectivity with customers and business partners. These firms are not strictly adopters because they do not have Web sites; hence they are classified as level 0 adopters.

**Level 1 – Web presence:** The first adoption level is Web presence. At this level, the firm has made the adoption decision but the implementation is still in process [6,7]. The purpose of adoption may be to occupy a domain name or simply to have Web presence. Generally, Web sites at this level provide mainly information and brochures, and tend to be non-strategic in nature.

**Level 2 – Prospecting:** The second level of adoption is named as prospecting. This is the limited use of the Internet without exploring the potential commercial opportunities provided by the Internet. Usually, Internet adoption initiatives at this stage are spearheaded by individual departments. Thus, they are with low strategic value and not tied to business strategy [4]. Most firms at this level establish Web sites to provide customers with product information, news, events, interactive content, personalized content, e-mail support, and simple search. This strategy is helpful in providing potential customers with access to the firm's products with minimal information distributing cost.

**Level 3 – Business Integration:** Business integration is the third level of adoption. At this level, Internet adoption is incorporated into the business model and integration of business processes is taking place. The value proposition is usually cost reduction and business support, and there are cross-functional links between customers and suppliers [4]. Moreover, Internet strategy is integrated with firm's business strategy.

**Level 4 – Business Transformation:** The fourth adoption level is business transformation. This is the highest level of adoption. At this level, Internet adoption will transform the overall business model throughout the organization. The focus is on building relationships and seeking new business opportunities.

### 3. Method

The sample was selected from the Singapore 1000 and SME500 directories. Only firms with Web sites and/or e-mail addresses were selected. Two rounds of pretests were conducted with students, faculty members and practitioners, and modified accordingly. The questionnaires were then sent by mail to IT managers or top executives (for firms without IT managers). A second mailing was carried out three weeks later. The final usable response was one hundred and fifty nine, resulting in a response rate of 28.8%.

The questionnaire captured data relating to Internet adoption level, impact of Web adoption level on competitive advantage, business strategy and demographic data.

### 4. Results

#### 4.1. Respondents' Profile

About 40% of respondents came from the manufacturing industry (23.3%) and the retailing and trading industry (15.7%), followed by the architecture and engineering industry (11.3%), the finance, banking and insurance industry (10.1%), and the business services industry (8.8%). Nearly 50% respondents are either IT Managers or Managing Directors, followed by General Managers/ Vice Presidents/ Directors (12.6%) and Finance/ Accounting Managers (10.7%). The average number of years they have served the company is 6.6, and the average number of years they have spent in the industry is 11.1. The high hierarchical level of the respondents coupled with the years of tenure in the company and industry further strengthens the validity of the sample since management level respondents are more likely to be knowledgeable about the use and impact of the Internet.

More than 40% of responding firms have average annual revenues of S\$100 million to S\$600 million, while about one-third have average annual revenues of less than S\$100 million. About 65% have less than 600 employees. Data show that establishing a Web site is relatively easy and inexpensive, because 44% of the participating firms spent less than S\$30,000 when they first created their Web sites. However, the maintenance of a Web site is more expensive compared with its establishment. About 45% of the participating firms invest up to S\$100,000 into Internet technology annually, and another 18% invest S\$100,000 to S\$300,000. Interestingly, it seems that a Web site can be easily maintained, because 60.4% of the participating firms have less than ten IT/ IS employees. One possible reason is that firms may have outsourced their Web sites maintenance to specialized Web service providers rather than increase the number of IT/IS employees.

#### 4.2. Adoption Level

Among the 159 respondents, the distribution of Web adoption levels is as follows: twenty-seven in level 0, forty-eight in level 1, fifty-two in level 2, eighteen in level 3, and fourteen in level 4.

#### 4.3. Firm Size and Adoption Level

A post hoc test was conducted using Tukey procedures on mean scores of the three indicators of firm size (number of employees, number of IT employees and revenue turnover) among the five adoption levels (Table 1). The results show that there is no significant difference on number of employees, number of IT employees and revenue turnover among adoption levels 0, 1 and 2, as well as among adoption levels 3 and 4. However, significant differences exist between pairs of Web adoption levels, i.e., levels 0, 1 and 2 from levels 3 and 4. These results indicate that there is a relationship between firm size and adoption level. It seems that two different types of adoption activities exist between larger and smaller firms, with larger firms being more involved in adoption levels 3 and 4, and smaller firms being more involved in adoption levels 0, 1, and 2.

#### 4.4. Business Strategy and Adoption Level

In the questionnaire survey, data of an organization's business strategy were collected in relation to whether it is a proactive strategy or a reactive strategy. Chi-square test ( $\chi^2=23.24$ ,  $df=4$ ,  $p < .005$ ) indicates that Internet adoption level is related to business strategy (Table 2). The results indicate that there are nearly equal number of proactive strategies and reactive strategies in this study, with frequencies of 84 and 75 respectively. In adoption levels 0 and 1, 66.7% and 64.6% of the organizations are reactive strategy takers respectively, while in adoption levels 2, 3, and 4, proactive strategy takers emerge as the dominant party, with proportions reaching 61.5%, 72.2%, and 92.9% respectively. This suggests that the more proactive an organization's strategy is, the higher the adoption level it will have.

#### 4.5. Firm Size and Business Strategy

Results show that except for the number of employees, both revenue and the number of IT employees are significantly correlated with business strategy, indicating that higher revenue turnover and more IT employees are more related with proactive business strategy (Table 3). This is consistent with Kowtha and Choon's [2] findings that firm size substantially influence the strategic commitment of a firm to e-commerce.

#### 4.6. Adoption Level and Competitive Advantage

The relationships between adoption levels and various dimensions of competitive advantage were assessed using one-way ANOVA and post-hoc Tukey procedures. Results indicate an increasing trend across adoption levels (Figure 1). As expected, the competitive advantage at adoption levels 3 and 4 are greater than levels 1 and 2. Results indicate that alliance, differentiation, innovation and growth advantages are affected more than cost advantages.

### 5. Discussion and Implications

The results indicate that there exist some relationships between Internet adoption level and firm size as well as firm's business strategy. Larger firms are

involved more in transactional Web site adoption, i.e., in adoption levels 3 and 4, while smaller firms are involved more in informational Web site adoption, i.e., in adoption levels 0, 1, and 2. This could be that to support transactional Web site, more technology investment, including capital and personnel, is required, which could be quite challenging to small businesses with relatively lower revenue income and resources. At the same time, firm size is positively related to business strategy, implying that larger firm size, which is represented by higher revenue turnover and more IT employees, tend to advocate a more proactive business strategy, and thus be related to higher adoption levels. In contrast, firms with relatively low revenue turnover, tend to prefer a reactive business strategy, leading to lower adoption levels. This result is important in terms of relating firms' Internet adoption activities with their strategic positions. Further research can be done to examine the relationship between business strategy and the two Web site categories. Moreover, researchers can use Miles and Snow's [5] typology of organizations, and examine the relationships between different strategic postures and adoption levels.

The results also indicate significant relationships between Internet adoption level and the five dimensions of competitive advantage. This is consistent with Lederer et al.'s [3] findings that the Web and electronic commerce improves firms' competitiveness. Among the five dimensions, alliance, differentiation, innovation and growth are affected the most by Internet adoption level. This suggests that the Internet offers an interactive channel for direct communication with customers and business partners thereby facilitating the formation of alliances and enhancing differentiation and growth. Further, firms have used the Internet for innovation and knowledge transfer rather than simply as a mechanism to lower costs [1]. Cost advantages appear to be least affected by Internet adoption level probably because cost advantages can be offset by high development costs of Web sites. Future research can further examine the sustainability of these competitive advantages resulting from Internet adoption. In addition, researchers can also examine whether predominant competitive advantages associated with different Internet adoption levels exist.

This study also has important implications to practitioners. Top management of firms should realize that the most basic function of a Web site is communication. It is a new channel to establish effective interactivity with customers and business partners. A firm deciding to adopt this technology should remember to provide their contact information on the Web site at least.

In addition, the positive relationships between Internet adoption level and competitive advantage should provide some assurances to practitioners that Internet investment is worthwhile. While firms may hesitate to invest in Internet technologies due to fear of rapid technological obsolescence, such firms may also risk losing their competitive edge by failing to leverage Internet technologies in their business strategies.

## 6. Conclusions

This study proposes a model of Internet adoption with five levels: level 0 – e-mail adoption; level 1 – Web presence; level 2 – prospecting; level 3 – business integration; and level 4 – business transformation. Higher Internet adoption levels tend to provide more extensive information and more transactional functions. The high extent of information and transaction features require technological support for advanced Web site features such as detailed and personalized information, advanced customer services and online business transactions. Thus possessing an advanced technology infrastructure could facilitate higher level Internet adoption.

Further, high level adoption is more prevalent among larger firms and those with a proactive strategic posture for the Web. This implies that as firms grow and become more familiar with the Internet, the features found on Web sites are likely to evolve over time, reflecting their changing objectives of Web sites.

The results also show that firms adopting Internet technology view innovation, alliance, differentiation and growth as more salient benefits than cost reduction. To achieve competitive edge, a firm needs to integrate its business activities with Internet adoption. In other words, the Web site's functions should be consistent with the firm's business strategy. Firms adopting Internet technology should view Web sites as a strategic move rather than a simple Web presence in order to derive greater benefits from Internet adoption.

## References

- [1] Campbell, A. & Mooney, B. "New value and electronic commerce: a pluralist perspective," In: *Global Business in Practice: Tenth International Bled Electronic Commerce Conference*, Bled, Slovenia, June 9-11, 1997, 112-1262.
- [2] Kowtha, R. & Choon, T.W.I. "Determinants of website development: a study of electronic commerce in Singapore," *Information and Management*, 2001, 39 (3), 227-242.
- [3] Lederer, A.L., Mirchandani, D.A. & Sims, K. "The link between information strategy and electronic commerce," *Journal of Organizational Computing and Electronic Commerce*, 1997, 7 (1), 17-34.
- [4] Lee, H.L. "Rethinking your business model: E-Commerce penetrating the business community," *Spotlight on Business*, November 19, 1999, 6-9.
- [5] Miles, R.E. & Snow, C.C. *Organizational Strategy, Structure, and Process*. McGraw-Hill, New York, 1978.
- [6] Sohn, C. & Wang, T.W. "Factors which facilitate a firm to adopt the Internet market," *Proceedings of the 1998 Americas Conference on Information Systems*, Baltimore, Maryland, August 14-16, 1998, 351-353.
- [7] Sohn, C. & Wang, T.W. "Diffusion factors and adoption levels of the Internet market: empirical analysis for the computer retailing companies," *Proceedings of the 1999 Americas Conference on Information Systems*, Milwaukee, WI, August 13-15, 1999, 259-261.
- [8] Teo, T.S.H., Tan, M. & Wong, K.B. "A contingency model of Internet adoption in Singapore," *International Journal of Electronic Commerce*, 1997-1998, 2(2), 95-118.

Table 1  
Firm size and adoption level

	Adoption Level									
	0		1		2		3		4	
Firm Size	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
No. of Employees	2.04 <sub>a</sub>	1.22	2.68 <sub>b</sub>	1.53	3.18 <sub>a</sub>	1.85	3.89 <sub>a</sub>	2.14	4.21 <sub>a, b</sub>	1.89
No. of IT Employees	1.11 <sub>a</sub>	.32	1.51 <sub>b</sub>	1.08	1.96 <sub>c</sub>	1.43	3.28 <sub>a, b, c</sub>	2.16	3.71 <sub>a, b, c</sub>	2.37
Revenue	1.93 <sub>a</sub>	1.04	2.02 <sub>b</sub>	1.14	2.30 <sub>c</sub>	1.54	3.39 <sub>a, b</sub>	2.09	4.23 <sub>a, b, c</sub>	2.05

Note: Means in a row sharing subscripts are significantly different at  $p < .05$   
For all measures, higher means indicate higher value

Table 2  
Business strategy and adoption level

Business Strategy	Adoption Level					Total
	0	1	2	3	4	
Proactive	9	17	32	13	13	84
	33.3%	35.4%	61.5%	72.2%	92.9%	
Reactive	18	31	20	5	1	75
	66.7%	64.6%	38.5%	27.8%	7.1%	
Total	27	48	52	18	14	159
	100.0%	100.0%	100.0%	100.0%	100.0%	

Table 3  
Business strategy and firm size

	Business Strategy	No. of Employees	No. of IT_Employees	Revenue
Business Strategy	1.000	-.145	-.205*	-.271**
No. of Employees	-.145	1.000	.763**	.653**
No. of IT_Employees	-.205*	.763**	1.000	.710**
Revenue	-.271**	.653**	.710**	1.000

\* Correlation is significant at the 0.05 level (2-tailed).  
\*\* Correlation is significant at the 0.01 level (2-tailed).

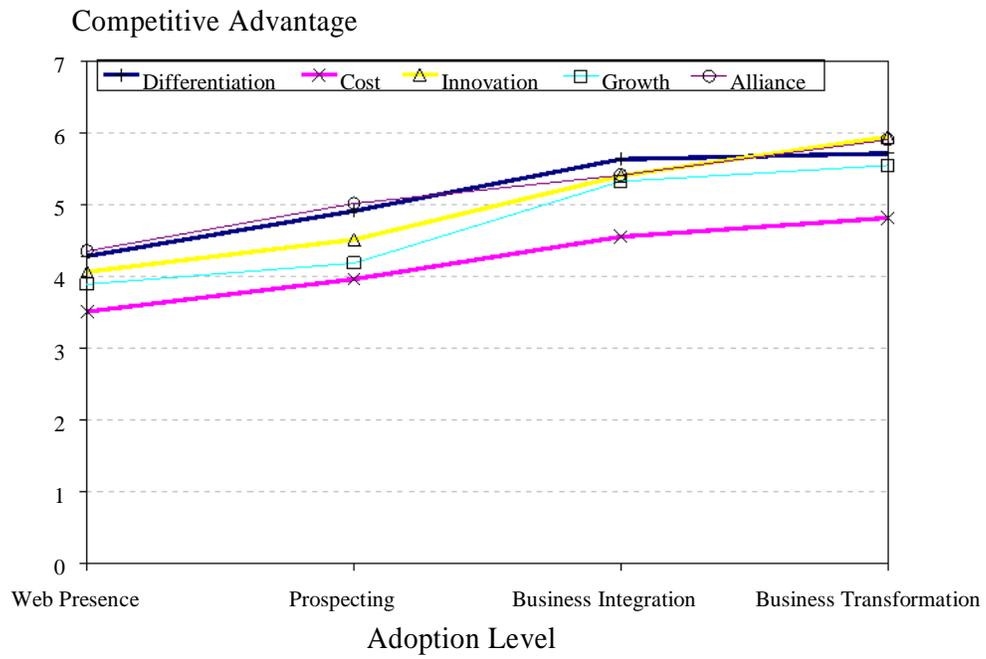


Figure 1. Adoption level and competitive advantage

# Investigating the Antecedents and Consequences of Attitude toward Web Site: A Web Content Attribute Perspective

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## Abstract

In recent years, most studies in the Attitude toward Web Site ( $A_{web}$ ) literature have been empirically scoped in shopping or commerce contexts and lack of systematic perspectives in investigations, therefore offered limited insights on guiding the knowledge for non-shopping web contexts, such as the online content industry. The purpose of this study is to choose the content attribute perspective to construct and empirically test a research model incorporating the antecedent and consequence variables of the  $A_{web}$  construct for the online content industry. After an extensive review on related literature, we propose 3 content attributes - informativeness, entertainment, and organization as the antecedent variables driving the  $A_{web}$  construct, which in turn explains the consequence variable set formed by intention to revisit, loyalty toward web site, and intention to future online commerce. For further testing the research model, a controlled survey methodology under laboratory environment is used. After collecting and analyzing 62 observations of psychological experience questionnaire for freely-browsed e-News sites on graduate student samples, all the research hypotheses are tested by using regression analysis and significantly supported. Encouragingly, this study successfully justifies the rationale that manipulating web site content strategies could lead to the formation of web users' attitudes and thus in turn explain and predict their subsequent online behavior.

Keywords: attitude toward web site ( $A_{web}$ ), content strategy, e-News site, online content industry

## 1. Introduction

### 1.1 Research Background

With the proliferation of WWW over the internet, both managerial academics and practices are eager to investigate why and how people like to visit certain sites, for keeping visitors means huge potential commerce benefits [26]. Responding to these managerial questions, there has been an emerging area concerning such issues in internet research. That is a concept termed as "Attitude toward web site" ( $A_{web}$ ), which is an academic construct that reflects a web surfer's predisposition of responding favorably or unfavorably to web content [5]. Studying the antecedent and consequence variables for the  $A_{web}$  construct can provide behavioral rationales for explaining

web surfers' web site preferences and related online behavior [2].

However, most studies in the literature have been empirically scoped in shopping or commerce contexts and therefore offered limited insights on guiding the knowledge for non-shopping web contexts, such as the online content industry. As a matter of fact, under shopping contexts, people exhibit more involvement and mental efforts for the information processing of consumer choice decision [4][23] and thus behave differently from non-shopping contexts like freely-browsed content sites. Therefore, a formal empirical study on the  $A_{web}$  construct for the online content industry is needed. Such a research will not only bridge the gap in the literature but also provide insights for the formation of web site strategies to help online content companies attract more visitors and enhance their web site performances. Aiming on attempting to step forward for the literature of internet research, this study is positioned as constructing and testing a research model incorporating the antecedent and consequence variables of the  $A_{web}$  construct for the online content industry.

### 1.2 Research Purpose and Questions

Previous studies concerning the  $A_{web}$  construct are fragmented and short of a specific perspective to systematically investigate the antecedents and consequences. Aiming on acknowledging such a deficiency in the literature, with the recognition that content strategy is one of the core competencies of content sites [11] [10], the purpose of this study is to choose the content attribute perspective to develop the research model for the  $A_{web}$  construct under the online content sites contexts.

Specifically, the research questions of this research are set as: (1) For online content web sites, what would be the appropriate set of antecedents determining the  $A_{web}$  construct from only the web site content attribute perspective? (2) And in turn, what consequences with business implications might be caused by the  $A_{web}$  construct?

### 1.3 Organization of This Study

The flow of this study is organized as follows. First, we briefly review related literature of the internet behavioral research,  $A_{web}$  research, respectively and then

give an overall commentary on the deficiencies of the body of literature. Second, a systematic research model with hypotheses is developed through the perspective of content attribute. Third, we propose a research design to empirically test our research model. Finally, we discuss the implications based on the findings of this study for both academics and practices and conclude with general recommendations for the online content industry.

## 2. Literature Review

### 2.1 Internet Behavioral Research

World Wide Web (WWW) has been considered as the emerging medium for marketing communication [3]. In recent years, innovation diffusion and consumer internet adoption have attracted many academic attentions [12] [19][18][28]. Also, with certain product categories, consumer buying has been modeled [20]. Another popular internet research topic is the web site effectiveness, where researchers have been focused on web site design features and content [10][27], profiling effective web sites [17], and the features that make a "good" web site [22] [9] [14].

### 2.2 Attitude toward Web Site

Attitudinal research has already been fruitful in the literature of behavioral science and marketing research [21]. Attitude is an important factor that determines human behavioral intentions and thus in turn drives

further actual behavior [1].

After the recognition that viewed WWW as a powerful medium for marketing communication, the attitudinal research concerning the web site inherit much knowledge from the literature of attitude toward the advertisement to study its causes and outcomes for electronic commerce strategies [5]. Understanding why and how people develop positive attitude toward the web site would be a great help to enhance the commerce performance for web sites. After comprehensively reviewing the empirical studies of the  $A_{web}$  literature, we can tell that there have been many factors associated with the  $A_{web}$  construct. It shows that the knowledge on  $A_{web}$  has started to accumulate and is waiting for further integration. For the purpose of sketching the whole picture of the  $A_{web}$  literature, we select antecedents, outcomes, empirical context, research methodology, and testing method as important attributes to profile each empirical reference. The descriptive findings are represented as Table 1 below.

### 2.3 Deficiency of the literature

After reviewing related literature, we can learn that the  $A_{web}$  construct has been drawing many attentions from the researchers. Many variables have been found associated with it, from both antecedent and consequence sides. Through the empirical validations of the linkage between  $A_{web}$  construct and web users' behavioral variables such as intention to revisit or shop, the  $A_{web}$  literature justifies its importance and business implications for the electronic

Table 1: Empirical literature concerning the  $A_{web}$  construct

Reference	Antecedents of $A_{web}$	Outcome of $A_{web}$	Web context	Methodology	Testing method
[29]	Convenience(+) Navigation(+) Economic incentive(+) Entertainment(+) Informativeness(+)		Book shopping	survey	correlation
[5]	Informativeness(+) Entertainment(+) Organization(+)		General	survey	Regression
[23]	Emotional rating(+) Rational rating(+)		Commercial	Experiment	Regression
[15]	Complexity(-) Novelty(+)	Desire to shop(+)	Shopping	survey	SEM - LISREL
[25]	Background complexity(-)	Advertisement attitude(+) Brand attitude(+) Purchase intention(+)	shopping	Experiment	ANOVA & Correlation
[30]	Convenience(+) Navigation(+) Economic incentive(+) Entertainment(+) Informativeness(+)		Book shopping	survey	SEM - EQS
[2]	Brand attitude(+) Involvement(+) Internet knowledge(+) Internet experience(-)	Time spent(+)	shopping	survey	SEM - LISREL
[6]	Usefulness(+) Ease of use(+) Enjoyment(+)		shopping	survey	SEM - LISREL
[7]	Interactivity(+) Vividness(+)		shopping	experiment	ANOVA
[16]		Intention to use information(+) Information use (+)	Commercial - Travel lodge	survey	SEM - LISREL
[26]	Brand loyalty(+) Functionality(+) Layout(+)	Intention to revisit(+)	Commercial - airline company	survey	Correlation & regression

commerce industry. Although we agree the  $A_{web}$  knowledge has begun to accumulate, we can observe that a systematic investigation of the  $A_{web}$  construct with both antecedent and consequence sides for the online content industry is still absent. Most studies are lacking specific perspectives and are thus fragmented, in addition, they are also empirically scoped under shopping or commerce web contexts, therefore providing limited insights for the  $A_{web}$  knowledge of non-shopping contexts.

Motivated by such a deficiency in the literature and acknowledging the practical importance to introduce the  $A_{web}$  research for the online content industry in order to understand the causes and outcomes of web users' psychological attitudes, this study is planned to adopt specific perspective suitable for the online content industry to systematically investigate the research model incorporating the antecedent and consequence variables of the  $A_{web}$  construct.

### 3. Research Model Development and Research Design

#### 3.1 Perspective selection

Previous studies concerning the  $A_{web}$  construct are fragmented and short of a specific perspective to systematically investigate the antecedents and consequences, and are not yet reaching into the non-shopping context domain. As a matter of fact, this study believes that choosing content attribute as the perspective to study the  $A_{web}$  construct would be a suitable cutting point for the online content industry.

Up to date, the profit source of the online content industry is still mainly stemmed from the traffic visited by web users. Most content web sites like e-News sites though pushing to their limits to explore profitable revenue models, however, web users' intentions to pay for online content remain poorly low [11]. Therefore manipulating content strategies to let web site favorable for web users and keep them revisiting to generate advertising revenue is the most important issue for the online content site managers [10].

Therefore, though there have been many antecedent factors shown in the literature, especially those individual characteristics like involvement, knowledge, and experiences, we believe that investigating content-related variables would mostly contribute to the formation of web site strategies. Because individual characteristics are usually not applicable for the web site holders, only studying content-related variables can be directly linking to the web design method and thus providing a more favorable site to create massive web traffic for generating huge advertising revenues.

The purpose of this study is to choose the content attribute perspective to develop the research model for the  $A_{web}$  construct under the online content sites contexts. After comprehensively examining the reference base, we believe informativeness, entertainment, and organization factors defined and measured by Chen and Wells could be a great framework to capture major conceptual nature of those content-related variables shown in the literature [5]. We firstly propose the research model depicted as Figure 1 below and then provide hypothesis derivations successively.

#### 3.2 Hypothesis derivation

The set of hypotheses of this study can be divided into two different parts, the confirmatory paths and exploratory paths. Confirmatory ones means they are derived with stronger theoretical basis and empirical supports, on the other hand, exploratory ones are those relationships that are incorporated into the model for the purpose of exploring the possibilities of empirical linkage among variables. We propose them as follows.

##### 3.2.1 Confirmatory Paths

In their important research findings, Chen and Wells have factor-analyzed 76 items pooled from an extensive review of attitudinal antecedent literature related to the WWW environment. They finally have extracted three meaningful dimensions formed by 16 items, and termed as the informativeness, entertainment, and organization

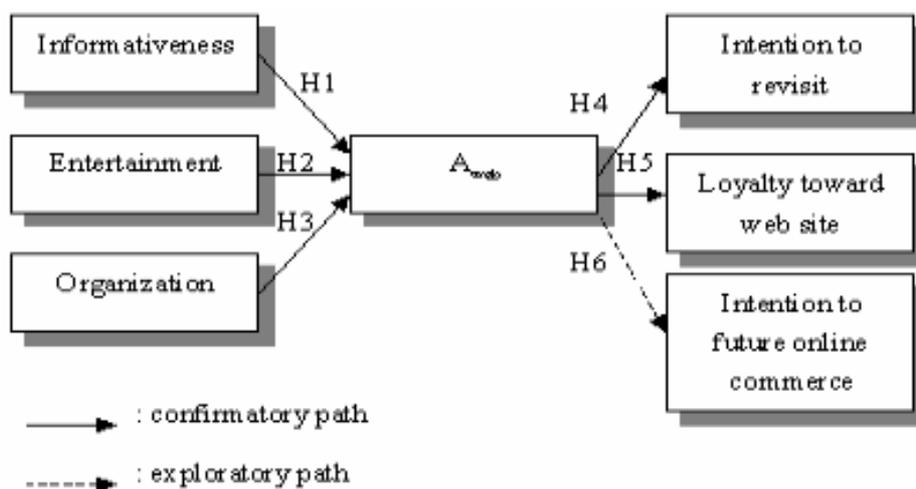


Figure 1 : Research model

respectively. These three dimensions reflect the content attributes perceived favorably by web users or not. Therefore, they can be described as the scores rated by web users in informational, recreational, and interfacial ways to judge the overall evaluations of a web site. Informativeness, entertainment, and organization have also been put into the regression model as the independent variables to explain and predict the  $A_{web}$  construct. In their empirical results, these three factors significantly account for 63% variation of the  $A_{web}$  Construct [5].

This is the most important literature that has formally verified these three factors in explaining the  $A_{web}$  construct. As a matter of fact, there have also been related literature providing more theoretical arguments and empirical supports. Childers et al. [6] have adapted the TAM theory [8] to propose the usefulness, ease of use, and enjoyment of web site content as the three antecedents for  $A_{web}$  and found to be positively significant. Similarly, Wu has also empirically validated that browsing convenience, navigational pleasantness, content entertainment, and content informativeness are significant factors associated with  $A_{web}$  positively [29][30].

We can observe that these factors are all close or similar to the three antecedent variables in this study, however, their empirical contexts are mostly scoped under shopping environment (please referencing Table 1). In responding to our research questions, for the online content industry, we expect that web users are not necessarily behaving the same as in the shopping web sites. Thus we are going to re-test the antecedent paths composed by informativeness, entertainment, and organization respectively to explain the  $A_{web}$  construct. The hypothesis 1-3 is proposed as below.

- ò H1: The perceived informativeness of web content will be positively associated with web users'  $A_{web}$ .
- ò H2: The perceived entertainment of web content will be positively associated with web users'  $A_{web}$ .
- ò H3: The perceived organization of web content will be positively associated with web users'  $A_{web}$ .

Intention to revisit has been empirically found to be positively influenced by the  $A_{web}$  construct. The more positive web users'  $A_{web}$  are, the more intentions they will exhibit to revisit that web site [26][16]. But this relationship has not been validated in non-shopping site contexts yet. Considering this variable is an important index for web site effectiveness and the need to re-test the consequence relationship for the online content industry, in addition, we are also attempting to even extend the explanatory ability of  $A_{web}$  to the loyalty level, thus we propose the hypothesis 4-5 as below.

- ò H4: The web users'  $A_{web}$  will be positively associated with web users' intention to revisit.
- ò H5: The web users'  $A_{web}$  will be positively associated with web users' loyalty toward web site.

### 3.2.2 Exploratory paths

In the exploratory part of the research model, though we are lack of theoretical support and empirical supports

for this path, we are going to verify this linkage between variables in order to explore more relationships for providing empirical basis of future substantive relationship development.

From the interviews of the CEOs of e-news site in Taiwan, we can observe that, being one sector of the online content industries, they are now more impatient with poor revenue statistics of web site. In their future strategic planning for web site business, they are going to explore more profitable business models including experimenting online transactional commerce which is still absent in their web site business scopes.

However, they are actually very concerned with the acceptability of their online users (<http://ceiba.cc.ntu.edu.tw/online/wwwboard/homework/index.html>). For the purpose of investigating that if it will also somewhat increase web users' intentions for future online commerce after they develop positive attitude toward web site, this study incorporates this exploratory path. We hope to answer this important managerial question for online content industries. Hypothesis 6 is proposed as below.

- ò H6: The web users'  $A_{web}$  will be positively associated with web users' intention to future online commerce.

## 3.3 Research Design

### 3.3.1 Measurement

All the research variables shown in the research model can be operationalized through referencing the well-developed instruments in the literature. We tabulate the variable name, number of items, scale type, and literature reference for each research variable as Table 2 below.

Table 2: Measurement of this study

Variable name	Number of items	Scale type	Source
Attitude toward web site	6	Metric, 5-point Likert Scale	[5]
Informativeness	6	Metric, 5-point Likert Scale	[5]
Entertainment	6	Metric, 5-point Likert Scale	[5]
Organization	4	Metric, 5-point Likert Scale	[5]
Intention to return	2	Metric, 5-point Likert Scale	[7]
Loyalty toward web site	2	Metric, 5-point Likert Scale	[26]
Intent to future commerce	2	Metric, 5-point Likert Scale	This study

### 3.3.2 Data Collection and Analytical Methods

The methodology of this study is positioned as a controlled survey, which is a questionnaire survey on subjects under specific task environment. We recruit 21 graduate student samples in university campus and invite them to participate this study in campus internet environment in order to rule out the interference effect of network quality.

The web context for the online content industry is set as the e-news sites, for their representativeness in the content provider industry [11]. The news sites held by the top three publishers in the newspaper industry in Taiwan are sampled as the stimulus to anchor the perceptions of research subjects (tabulated as Table 3). Because each site has its features and strategies somewhat differently, we

expect these sites could create sufficient variations in web users' perceptions and therefore better than a single-site empirical design.

Table 3: e-News site pool of this research design

Newspaper publisher	e-News site
The China Times	http://news.chinatimes.com/
The United Daily News	http://www.udnnews.com/
The Liberty Times	http://www.libertytimes.com.tw

The researchers of this study will adopt a systematic rotating technique to produce the site visiting list for each subject in order to avoid the systematic perception bias caused by fixed visiting orders of web users. The procedure is to let subjects follow their given lists of visiting news sites and freely browse each site for a certain period of time. After finishing browsing a site, he/she will be asked to complete the questionnaire for that site. Therefore, a total sample size of twenty one graduate students is planning to create 3X21=63 observations for further data analysis.

Besides basic descriptive analysis of the sample data, for all the variables collected by the instruments are metric scales, this study uses the factor analysis to validate the measurement models and then multiple regression method to test the substantive relationships of the research model [13]. After analyzing the empirical data set by SPSS 8.0 for Windows, all the confirmatory and exploratory paths are verified and thus provide the empirical testing results for the hypotheses within the research model.

#### 4. Data analysis

##### 4.1 Descriptive Analysis of Samples

After examining the data set, a data set containing 62 effective observations of questionnaire is obtained. We tabulate gender, age, internet usage in Table 4-6 for the sample subjects to sketch the sample characteristics.

Table 4: Gender profile of samples

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Female	8	12.9	12.9	12.9
Male	54	87.1	87.1	100.0
Total	62	100.0	100.0	

Table 5: Age profile of samples

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 23.00	15	24.2	24.2	24.2
24.00	12	19.4	19.4	43.5
25.00	20	32.3	32.3	75.8
26.00	3	4.8	4.8	80.6
27.00	6	9.7	9.7	90.3
29.00	3	4.8	4.8	95.2
39.00	3	4.8	4.8	100.0
Total	62	100.0	100.0	

From these descriptive tables above, we can observe the sample features to assess the sample quality of this study. They are mainly male, young, and are internet expert users with at least 3 years of internet usage experiences. Therefore collecting convenient sample for the purpose of adopting the controlled survey methodology turns out to receive a too homogenous

sample pool and thus severely threatens the external

Table 6: Internet usage profile of samples (in years)

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 3.00	3	4.8	4.8	4.8
5.00	9	14.5	14.5	19.4
6.00	27	43.5	43.5	62.9
7.00	17	27.4	27.4	90.3
8.00	3	4.8	4.8	95.2
10.00	3	4.8	4.8	100.0
Total	62	100.0	100.0	

validity of this study.

##### 4.2 Instrument Validation

In this study, totally 28 5-point scale variables for measuring 7 factors shown in the research model are collected. Although these measurement models are mostly introduced from well-developed instruments in the literature, in order to ensure the construct validity under the empirical context of this study, principal component factor analysis is used to validate the measurement models. All the factor solutions with reliability Alpha are provided as Table7 below. We can observe that each measurement model produces one-factor solution and acquires the Alpha value in the interval of 0.77-0.95. It shows the measurement model quality of this empirical study is extremely desirable and free from the concerns of construct validity and reliability.

##### 4.3 Hypothesis testing

###### 4.3.1 The Antecedent Model of A<sub>web</sub>

In hypothesis 1-3, we propose the antecedent model for the A<sub>web</sub> construct. These paths are verified simultaneously with a multiple regression model incorporating 3 independent variables. The A<sub>web</sub> construct is regressed on informativeness, entertainment, and organization of the web content. As depicted in Figure 2 below, it shows that these paths are all corroborated in this study. They pass the F-test and t-test of regression analysis at 0.000 significance level and explain nearly 80% variance of the A<sub>web</sub> construct (R<sup>2</sup>=0.797). Therefore, hypothesis 1-3 are supported in this study.

###### 4.3.2 The Consequence Model of A<sub>web</sub>

In hypothesis 4-6, we propose the consequence model for the A<sub>web</sub> construct. These paths are verified separately with 3 simple regression model incorporating only the A<sub>web</sub> construct to explain the consequence variables. The A<sub>web</sub> construct is used to regressing intention to revisit, loyalty toward web site, and intention to future online commerce separately. The results show that these paths are all corroborated in this study. They pass the F-test and t-test of regression analysis at 0.000 significance level. And the A<sub>web</sub> construct can explain 72.5%, 38.6%, 52.6% variation for intention to revisit, loyalty toward web site, and intention to future online commerce respectively. Therefore, hypothesis 4-6 are supported in this study as well.

Table 7: Measurement model validations with reliability estimates

Attitude toward web site, Alpha = .9077		Informativeness, Alpha = .8929	
Item	Factor Loading	Item	Factor Loading
Aweb1	0.74	Inf1	0.77
Aweb2	0.89	Inf2	0.77
Aweb3	0.82	Inf3	0.77
Aweb4	0.86	Inf4	0.87
Aweb5	0.79	Inf5	0.74
Aweb6	0.88	Inf6	0.81
Variance extracted	69.41%	Variance extracted	65.09%
Entertainment, Alpha = .9285		Organization, Alpha = .8659	
Item	Factor Loading	Item	Factor Loading
Ent1	0.85	Org1	0.81
Ent2	0.90	Org2	0.86
Ent3	0.90	Org3	0.89
Ent4	0.90	Org4	0.80
Ent5	0.87	Variance extracted	71.41%
Ent6	0.86		
Variance extracted	76.93%		
Intent to return, Alpha = .9421		Loyalty toward web site, Alpha = .7790	
Item	Factor Loading	Item	Factor Loading
InfRet1	0.97	Loy1	0.90
InfRet2	0.97	Loy2	0.90
Variance extracted	94.53%	Variance extracted	81.64%
Intent to future consumers, Alpha = .8507			
Item	Factor Loading		
Future1	0.98		
Future2	0.98		
Variance extracted	95.31%		

## 4.4 Discussions

### 4.4.1 For antecedent variables

From the empirical findings of this study, we can observe that in online content industry context (e-news web sites), the explanatory capability of 3 content attribute factors is even stronger than in shopping context investigated empirically in the literature. Chen and Wells have ever reached the 0.63 level of R square and concluded with the emerging opportunity of the  $A_{web}$  prediction theory [5]. In this study, we are interested in the non-shopping context and re-test the content attribute antecedent model for the e-news site industry. By using the controlled survey methodology, we amazingly achieve the 0.797 level of R square toward explaining the  $A_{web}$  construct. Therefore we find that the antecedent structure is more suitable for explaining  $A_{web}$  in digital content industry, and we also develop a more robust basis of the  $A_{web}$  prediction theory for the academic literature from the web content attribute perspective. Although there have been many variables shown in the  $A_{web}$  literature (please referencing Table 1), now it can be claimed that content-related variables, namely, informativeness, entertainment, organization are the most major explaining

system for the  $A_{web}$  construct and therefore provide the rationale for people's preference of web sites.

Besides that, we also observe that the influencing effects of 3 content attribute factors are different from those empirically explored in the literature. For e-news web sites, entertainment factor is the most important factor influencing  $A_{web}$  (Standardized beta coefficient: entertainment 0.42, > informativeness 0.40 > organization 0.30). Compared to the Chen and Wells' study [5], the influencing effect of informativeness is much decreased in strength, and the effect of organization factor is remained the weakest (in their findings, Standardized beta coefficient: informativeness 0.57 > entertainment 0.34 > organization 0.22).

The possible explanations of the findings above may be attributed to the motivational factors of web users and the information quality of online content providers. According to the annual internet surveys conducted by one of the largest portal sites in Taiwan, in recent years, seeking for recreational entertainment source of digital content has been one of the major activities performed by web users of e-news sites (<http://survey.yam.com/index.html>). Therefore from the view point of motivational reasons, being satisfied by the entertainment attributes of a web site is going to generate the most positive experiences for web users and thus develops the most favorable attitudes toward a site.

On the other hand, online content providers today are facing channel conflict dilemma among content delivery vehicles. Being driven by fearing the decline of physical material sales, they are reluctant to offer high quality information online. This leads to lower the average level of expectations of web users for acquiring knowledgeable information on news sites and thus might dilute the effect of informativeness on  $A_{web}$ .

### 4.4.2 For consequence variables

From the testing results of the consequence model of the  $A_{web}$  construct we can learn that  $A_{web}$  can both significantly affect intention to revisit and loyalty toward web site, however, the  $A_{web}$ -Loyalty relationship is much weaker.  $A_{web}$  accounts for 72%, 38% variation for intention to revisit and loyalty toward web site respectively. This finding may be not so good for web site managers, for putting huge efforts to develop and

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.897 <sup>a</sup>	.797	.780	3.366

a. Predictors: (Constant), ORG, INF, ENT

Coefficients <sup>a</sup>						
Model		Unstandardized Coefficients		Standardized Coefficient	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.803	.288		-1.747	.086
	INF	.481	.099	.400	5.391	.000
	ENT	.404	.071	.428	5.712	.000
	ORG	.312	.065	.303	4.751	.000

a. Dependent Variable: AWEB

Figure 2: Regression analysis for testing the antecedent model of  $A_{web}$

implement web content strategies may just only well pay off on attracting people to come back to site in the future but not on receiving sufficient loyalty from their web users. Site managers have to face the reality that in internet business, if other sites provides stronger incentives, then their online users may just switch easily and quickly. Although  $A_{web}$  affects loyalty significantly, the site managers are still obviously risky at relying on the content strategies to develop user loyalty. Seeking for other more effective means of web site strategies to combine with or replace content strategy still challenges the site managers.

However, surprisingly, we find  $A_{web}$  does build a relationship with intention to future online commerce.  $A_{web}$  accounts for over 50% variation of it ( $R^2=0.52$ ). We can now confirm the conjecture that striving for  $A_{web}$  will also pay off on the electronic commerce perspective. News site users tend to be willing to transact with sites responded favorably in the future. Although this relationship means little in theoretical contributions, however, it is going to greatly inspire online content providers for already offering the confidence for future strategic planning of entering electronic commerce. This study creatively and successfully relates the  $A_{web}$  construct to intention to future online commerce. Of course it's only an exploratory finding and thus needs to be validated with better research design by future studies.

## 5. Conclusion

The purpose of this study is to choose the content attribute perspective to develop and test the antecedent and consequence model for the  $A_{web}$  construct under the online content sites contexts. By using the controlled survey methodology with graduate student samples, all the research hypotheses are supported. The main empirical results can be summarized and depicted by mapping back to the research model as Figure 3 below.

### 5.1 Contributions and Implications

Selecting the content-related variables as the perspective to construct the research model for the  $A_{web}$  construct with online marketing variables provides an point of view that links the content strategies of web sites

to web users' psychological attitude and behavioral outcomes. With the derivation and empirical testing these relationships among research variables, we justify the rationale that manipulating web site strategies could lead to the formation of web users' attitudes and thus in turn explain and predict their subsequent online behavior.

It is certainly that such a research model should be taken into further empirical validation for clarifying the substantive relationships. However, this study already provides both the logical derivations of model building and feasible operationalization approach of empirical research design to verify hypothetical relationships among variables and thus contributes to the theory building and testing for the electronic commerce literature. Besides, linking the web content strategies to web site business-related outcomes via the attitudinal construct helps us to successfully cope with the most urgent managerial issues for the online content industry.

From the empirical testing of such a research model, we can tell the influencing effect of every single model path and thus develop the knowledge for the impact of web site content strategies on  $A_{web}$  and those important indices of web site effectiveness, such as intention to revisit and loyalty toward web site. It can directly help the web site managers to adjust their ways of web site design. Based on the empirical findings, for the e-News site industry, we recommend to pursue entertainment strategy first in order to directly meet most web users' expectations and satisfy their online motivations. Compared to informativeness and organizational factors, providing interesting and attracting recreational content will contribute most effectively to develop web users' favorable attitudes.

We also put important online marketing variable like future online commerce intentions into the model. Such an attempt is even beyond the web site business scope and therefore facilitating the formation of the corporate level strategies to explore the potential of entering into the transactional online commerce activities for the newspaper industry.  $A_{web}$  is found to be significantly associated with web users' intentions to future online commerce thus providing a good message for the online content providers to bravely attempt building transactional relationships with their web users.

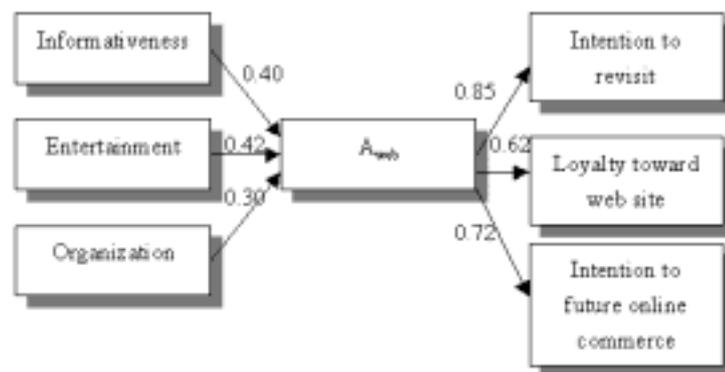


Figure 3: Research finding summary of this study (paths are labeled with standardized beta coefficients obtained by regression analysis )

## 5.2 Limitations and Recommendations

Although variables shown in the research model provides significant implications for both the managerial research and practices of the electronic commerce, readers ought to pay attentions to the interpretations of the findings in this study. What we claim and focus for the model building is via the web content-related perspective and thus offering limited scope for the explanation and prediction toward the  $A_{web}$  construct and subsequent dependent variables. As a matter of fact, there have been fruitful in the exploration of explanatory variables for the web site attitudinal research. Individual characteristics such as involvement, internet knowledge, and experiences have also found to be empirically associated with the  $A_{web}$  construct [2]. In addition, other web site attracting strategies such as providing economic incentives for web users also identify the utilitarian rationale for developing positive attitude toward sites [29][30].

In other words, there are still lots of potentials in this area of research. Future studies should attempt to explore more antecedent views with more business outcomes of online marketing for the  $A_{web}$  construct to enrich the theoretical systems of the web attitudinal research, and thus continuing to uncover the phenomenon of people's preference to stick with certain web sites and its possible behavioral outcomes as well. And certainly, the sample quality concern that threats most severely to the external validity of this study has to be relieved by future studies. Larger sample size and more heterogeneous sample characteristics are more desirable to effectively estimate the real pictures of internet user population.

Individual psychological constructs are very popular and playing important roles in the consumer behavior literature, however, they are still relatively unexplored in the web site effectiveness literature. This study puts lots of efforts into the preliminary attempt to investigate the phenomenon of why people respond to certain web sites favorably and explore its potential online marketing outcomes. We hope to introduce an innovative perspective and thus inspire more future studies to enrich the electronic commerce management literature.

## References

- [1] Ajzen, I. and M. Fishbein, *Understanding Attitude and Predicting Social Behavior*, Prentice-Hall, USA, 1980.
- [2] Balabanis, G. and N. L. Reynolds, "Consumer Attitudes towards Multi-channel Retailers' Web Sites- The Role of Involvement, Brand attitude, Internet Knowledge and Visit Duration," *Journal of Business Strategies*, 2001, 18, 2, 105-131.
- [3] Berthon, P., L. Pitt, and R. Watson, "Marketing communications and the world wide web," *Business Horizons*, 1996, Sep-Oct, 24-32.
- [4] Bettman, J. R., *An Information Processing Theory of Consumer Choice*, Addison-Wesley, USA, 1979.
- [5] Chen, Q. and W. D. Wells, "Attitude toward the site," *Journal of Advertising Research*, 1999, Sep/Oct, Vol. 39, Iss. 5, 27-37.
- [6] Childers, et al., "Hedonic and utilitarian motivations for online retail shopping behavior," *Journal of Retailing*, 2001, 77, 511-535.
- [7] Coyle, J. R. and E. Thorson, "The effects of progressive levels of interactivity and vividness in web marketing sites," *Journal of Advertising*, 2001, XXX, 3, Fall, 65-77.
- [8] Davis, F. D., "Perceived usefulness, perceived ease of use, and user acceptance of information technology," *MIS Quarterly*, 1989, 13, 3, 319-340.
- [9] Dholakia, U. M. & L. L. Rego, "What makes commercial web pages popular? An empirical investigation of web page effectiveness," *European Journal of Marketing*, 1998, 32, 7-8, 724-737.
- [10] Dreze, X. & F. Zufryden, "Testing web site design and promotional content," *Journal of Advertising Research*, 1997, Mar/Apr, 77-91.
- [11] Eisenmann, T. R., *Internet Business Models - text and cases*, McGraw-Hill company, USA, 2002.
- [12] Gupta, S. and C. Rabikar, "Consumer and corporate adoption of the world wide web as a commercial medium," in Peterson, R. (Ed.), *Electronic Marketing and the Consumer*, Sage, USA, 1997.
- [13] Hair, J. F., R. E. Anderson, R. L. Tatham, and W. C. Black, *Multivariate Data Analyses – 5th edition*, Prentice Hall, USA, 1998.
- [14] Hofacker, C. F. & J. Murphy, "World wide web banner advertisement copy testing," *European Journal of Marketing*, 1998, 32, 7-8, 703-713.
- [15] Huang, M. H., "Information load: its relationship to online exploratory and shopping behavior," *International Journal of Information Management*, 2000, 20, 337-347.
- [16] Jeong, M. and C. U. Lambert, "Adaptation of an information quality framework to measure customers' behavioral intentions to use lodging web sites," *Hospitality Management*, 2001, 20, 129-146.
- [17] Johnson, B. et al., "Ad age's cybermarketing leaders," *Advertising Age*, 1995, Sept 18, 66, 37.
- [18] Keeling, K. A., D. Fowler, & P. J. McGoldrick, "Electronic banking customers: determinants of adoption and retention," *Proceedings of the 27th EMAC Conference*, 1998, Stockholm, Sweden, 6, 535-554.
- [19] Keeling, K.A. and P. J. McGoldrick, "The acceptance of electronic shopping: a question of control?," *Proceedings of the 26th EMAC Conference*, 1997, Warwick, UK, 2, 669-688.
- [20] Liang, T. P. & J. Huang, "An empirical study on consumer acceptance of products in electronic markets: a transaction cost model," *Decision Support Systems*, 1998, 24, 1, 29-43.
- [21] Lutz, R. J., "The role of attitude theory in marketing," in *Perspectives in Consumer Behavior*, 4th ed., Prentice-Hall, USA, 1991, 317-339.
- [22] McMurdo, G., "Evaluating web information ad design," *Journal of Information Science*, 1998, 24, 3, 192-205.
- [23] Pereira, R. E., "Factors influencing consumer perceptions of web-based decision support systems," *Logistics Information Management*, 1999, 12, 1/2, 157-181.
- [24] Singh, S. N. and N. P. Dalal, "Web home pages as advertisements," *Communications of The ACM*, 1999, 42, 8, 91-98.
- [25] Stevenson, J. S., G. C. Bruner II, and A. Kumar, "Webpage background and viewer attitudes," *Journal of Advertising Research*, 2000, Jan/Apr, 29-34.
- [26] Supphellen, M. and H. Nysveen, "Drivers of intention to revisit the websites of well-known companies- The role of

corporate brand loyalty," *International Journal of Market Research*, 2001, 43, 3, 341-352.

[27] Vrolijk, H. et al., "Experimental research on the effectiveness of web sites," *Proceedings of the 27th EMAC Conference*, 1998, Stockholm, Sweden, 4, 299-311.

[28] White, M. D., E. G. Abels, & L. Murnane, "What constitutes adoption of the web: a methodological problem in assessing adoption of the world wide web for electronic commerce," *Proceedings of the ASIS Annual Meeting*, 1998, 35, 217-226.

[29] Wu, C. M., "Factors influencing web users' attitude and

shopping intentions - a online bookstore shopping context," *Information Management Research (in Chinese)*, 1997, 2, 1, 1-22.

[30] Wu, C. M., "The causal relation between the characteristics of web, web users attitude and intention to purchase," *Journal of Business Administration (in Chinese)*, 2000, 46, 33-48.

## A Taxonomy of Operation Priorities in China

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### Abstract

This paper presents taxonomy of operations priorities using data collected from 175 companies in China. The taxonomy of operations priorities in China are found to be quite different from what was observed in previous studies (Miller and Roth 1994; Kathuria 2000; Frohlich and Dixon 2001). The result of this study supports the view that the types of the operations strategies used by companies are different in different parts of the world and are influenced by the competitive environment (Frohlin and Dixon 2001).

This paper also compares the use of the competitive strength and importance rating of the operation priorities to develop the taxonomy and found that competitive strength measures are more reliable and can better explain company's performance and their emphases on management programs. The paper advocates the use of competitive strength rather than importance in future research on operations strategy.

Keywords: Operations Priorities/Strategy;  
Manufacturing Strategy in China

# Research on the Individuation of Client-Centered Ecommerce

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## Abstract

Many enterprises all over the world plunge into developing ecommerce in recent two or three years, but don't attain their expectant goals. Taking Chinese enterprises as the example, through analyzing the individuating trend of consumption and the operating status of ecommerce, this paper emphasizes that only the enterprises develop client-centered ecommerce considering their practice conditions can they fit the individuating trend of consumption and ecommerce, and puts forward some proposals for the individuation of this client-centered ecommerce for enterprises in new century.

## 1. Introduction

Internet brings one world-shaking change for people's daily life and economic activities. The enterprises worldwide trade with others on Internet, which is called ecommerce, this raises the producing efficiency and decreases the cost of the management, but also enlarges the production market and enhances the enterprise's strength. The traditional trade mode is receiving more and more challenges from this new trade mode on Internet. Chinese enterprises also plunge into ecommerce with great ardor in recent two or three years, but don't attain the expectant goals with the further development of ecommerce and Internet economy. Some new problems are appearing too such as the individuation of consumption and ecommerce. More and more enterprisers and scholars are analyzing these problems and trying to find some good methods which can help the enterprises do better and client-centered ecommerce and get better return. Some solutions are put forward such as cooperative business, synergic business and etc. Most of these solutions base on the theory demand and prefabricate some fixed stencils, but are not practical enough to fit the current practical condition of all enterprises from different countries. So the proper development strategy of client-centered ecommerce for meeting the individual needs of clients is needed very much by many enterprises, especially for Chinese enterprises.

## 2. Individuating Trend of Consumption and Ecommerce

There are enough and almost all kinds of commodities in human society now through more than 100 years' industry revolution, adding the fast

development of information technology with computer as a representative, these can gradually meet the individuation needs of consumers which are upswing, such as individuated cars, individuated houses, individuated home appliances, individuated clothes and individuated computers. Thus the individuated productions and individuated services have become the leading tide of our new age with client-centered concept. When one enterprise is regarded individuated, this means larruping and can get more consumers' more attention and consider more from the side of clients. Now almost all enterprises worldwide are in pursuit of their individuation. For instance, the famous retail enterprise of USA, Roudster-Rom Corp., makes one management tenet that the enterprise will satisfy any consumer's needs. When one consumer does business with this enterprise, besides the commodities, he will also be received a series of services such as the consultation and being run after. The relation between the consumer and the enterprise isn't ceased with the end of shopping and will continue for a long time, maybe the whole life of the consumer. This strategy gives the consumer one comfortable family feeling.

The consumer feel more convenient and save money by the means of doing shopping on Internet, but he also lose the satisfaction which is full of the milk of human kindness offered by traditional trade way, what he can see and get is infinite information on Internet and formatted service by the silent machine. For the enterprise, the lead of technology is temporal, the predominance is no longer easy to be acquired by the lead of technology now. Whenever and wherever Internet directly push the enterprise to the front of consumers and let the enterprise face more and more individuated demands. So, only the enterprise can provide characteristic services aiming at kinds of consumers by combining some traditional marketing means and Internet technology, it will be a simon-pure winner. The individuation of ecommerce comes forth following this demand, that is client-centered and providing the individuated services and products on Internet. It has the following two contents:

First, the custom-tailored service and merchandise full of individuation. Because of the difference of individual conditions, the clients' demands are different too. For the commodity with higher content of technology, the consumer no longer receives it just passively while the businessman no longer only provides many selections, he will take part in the processes of the commodity's design and production with his individual

love. Now whether the enterprise can provide more individualized services or not comparing with traditional companies becomes the key factor for a successful or a failed ecommerce.

Second, the custom-tailored information full of individuation. Internet makes it possible to custom-tailor information following the consumer's wish, this means huge business chances. The personal electronic newspaper provided by New York Times early is a good example. The best characters of Internet is real time and dynamic exchange, in virtue of this, consumers can enjoy the function of VOD, but also can take part in the design and production of the TV programs.

### 3. Analysis of Chinese Ecommerce

Internet is influencing almost all the fields of Chinese society and culture deeply like it does in other countries. In the end of the year 2001, the total number of Internet users in china has exceeded 30 million and is increasing at a double surprised speed every year, the number of Chinese websites has more than 800000 while the number of government internet websites reach 3000. In addition, more than 1 million small companies, 10000 moderate and 100 large enterprises have connected to Internet. With a good Internet environment comes into being in china, doing ecommerce on internet is increasingly becoming one important way for one enterprise changes to be more competitive in new century. The representative door websites like Sina, Sohu, Tom, Capital Online develop ecommerce one after another; the traditional IT products manufacturers and sellers state their ecommerce development strategies and ecommerce productions early or late; the professional ecommerce websites including more than 100 thousand kinds of merchandises like 8848 and DangDang develop very quickly. In general, all kinds of enterprises want to expand themselves by this new business way of doing ecommerce.

But Chinese enterprises are changing from planned economy system to market economy system and haven't enough market experiences, so, many of them just imitate the ecommerce mode of foreign enterprises simply, establish Internet website, issue information and do business on Internet, etc. They have not enough experiences or time or skills to make one analysis that whether the practical conditions of the enterprises fit for doing ecommerce or not and how to do first. The result is disappointed. Chinese enterprises' current status of developing ecommerce is: ecommerce has been developed vigorously and busily on the surface in recent two or three years, but the result is the little proceeds comparing the huge investment, some even deal losing money in business now; the total amount of ecommerce is so small and less than RMB5000 million in the year 2001; the development level of ecommerce is still resting on one lower level and the ecommerce upsurge like in America don't emerge in china.

There are many reasons causing this result, the main factors are described as following:

First, imitate the ecommerce mode of foreign

enterprises simply while not considering the practical condition of the enterprise carefully and insist on having done all things by one step excessively and seek to set up one complete and consummate ecommerce platform. Such as whether the products are fit to do ecommerce or not, whether the quality of the employees and departments fit to develop ecommerce or not, etc.

Second, the ecommerce contents are very finite and the marketing means are simple and bald, lack of individuality, so these still can't arouse and stimulate the consuming appetite of Chinese people and change their traditional consuming conception which formed for a long time.

Third, there isn't one enough and full estimate about the influences for china's incomplete ecommerce environment, such as relative poor Internet establishments, more expensive Internet fee, not too reliable security technology of Internet and information, shortage of the organizations for ecommerce's notarization and arbitration, etc.

Forth, the management, establishment and technology of physical distribution in China is very poor, the advanced third-party system is lacked very much. This situation make it very finite of the ecommerce developing area for one enterprise and can't ensure providing in-time service of sending the goods, say nothing of sending goods spanning areas. It is unimaginable if one enterprise can develop ecommerce fast in a large scale and get one good repay in this condition.

Last, Chinese enterprises are still not used to accept the concept of client-centered for their long history of the planned economy system.

### 4. The Proposals for the Individuation of Client-Centered Ecommerce

According to the ecommerce developing status of Chinese enterprises and the individuating trend of ecommerce, many project providers have put forward a lot of ecommerce solutions, such as cooperative business, synergic business and etc. Most of these projects base on the theory demand and prefabricate some fixed stencils. For example, some providers emphasize beginning with ERP of the enterprise inside, some pay stress on the visualization of the enterprise. Analyzing these projects carefully, we can find out that these stencils lacking flexible, which can not reflect the peculiarity of each enterprise and can not accommodate to new circumstances. In order to improve the efficacy of ecommerce and adapt to the individuating trend of ecommerce, Chinese enterprise should consider comprehensively the circumstance of capital, the operation trait and economy environment so as to plan the individualized ecommerce strategy suited to each enterprise.

4.1 Analyze the latent customers of enterprise's products, their consumption ability, the ecommerce possibility of products and the

investment risk through decision adviser consulting, find out one appropriate entry to begin with and ascertain the development direction of ecommerce. Notice the key point.

Ecommerce is investment, not consumption. The enterprise should evaluate the situation of present competitor and the character of its products carefully, according to own limited financial and material resources, find one appropriate entry to begin developing ecommerce instead of doing with all-sides. Each kind of merchandise has specific user group. Each group has the preference, consuming ability and consuming habit, the enterprise should analyze the market fully in order to find accurate product location. For example, Shanghai Maydeal Science and Technology Corp. set up one nationwide professional medical electronic market: www.maydeal.com in June 2000. The company adopts the strategy which meeting enterprises' demand, selects medical consumable goods as an entry to do ecommerce, offers a professional medical ecommerce platform for professional buyer and medical product supplier which has definite classification and complete kinds of goods. Although Maydeal website was set up only one year ago, now it has been beginning to establish its leading market position in China.

4.2 Begin from demand chain, combine BPR and Client-Centred concept, pay more attention to use social resources and explore one series of flexible business processes that suits ecommerce development.

The business process of ecommerce is other than that of traditional business, which also differs from each other because of different trade and different enterprise. When designing the business process of ecommerce, the enterprise should consult experts and customers, consider problems from the demand chain, accord with the individuated demands of consumers as far as possible, give fast feedback and notice to evaluate the work efficiency of the process and adjust it in time. For example, the operation process developed by Qingdao Haier Group which can make fast feedback on network offers the individuated service that the distributor can custom made refrigerators. This gets warm welcome of dealers, and helps Haier and numerous dealers get better return together.

4.3 According to the development trend of ecommerce and the characters of business process, purchase the ecommerce technical platform or unite to develop one. When implementing, perfect each module step by step, pay attention to the cooperation with traditional commercial pattern and prevent from pursuing success immediately or just at one step.

The enterprise should go to consult the experts who can make careful analysis about the management scale,

the trade and business characteristics, and give good proposals according to actual circumstances to the enterprise. If condition permitted, it is a good idea to develop the corresponding ecommerce technical platform by uniting other professional companies, and perfect it modularly step by step. By this way, the technical solution of ecommerce can suit the customers better, provide and add peculiar services for the clients in time.

4.4 In place of establishing the ecommerce platform solely at one huge cost, develop net cooperative business between enterprises actively, construct and support a harmonious and uniform market environment for sharing the resources and benefits. This also can meet the individuated needs of customers better and realize the enterprise's durable development of ecommerce.

Since Chinese enterprises contact market economy lately, they lack enough understanding of market risk and market competition. They always like to do business by themselves and do not pay attention to the cooperation between the enterprises and the use of social resource, so as to increase operation cost and market risk. So does in the field of ecommerce. For Instance, not long ago, some name brands domestic companies, such as Chunlan, Haier, Midi and so on, throw huge capital respectively on internet and build each ecommerce platform, in order to construct one B to B and B to C system which has the capacity to realize the functions such as sales online, delivery online and purchasing online in global scope. But the results may not as their hope. On the contrary, considering the construction and maintenance of common market environment, the long-term development of market and the long-term benefit of customers, three famous world-class corporations, General Motor, Ford and Daimler-Chrysler, decide to give full cooperation to found and run one common online B to B website instead of building the competitive and independence B to B website each. Besides, about the management of physical distribution in support ecommerce development, according to the facts of low profits in Chinese transportation enterprises, lot of assets leaving unused and growing unemployment, the enterprise can use these social resources fully, organize and manage them efficiently, design one work process of physical distribution to satisfy the customers and cooperative partners just at low cost.

4.5 Explore the marketing strategy of ecommerce actively. Maintain some operating ways of traditional business to meet the need of the continuity of customer habits, but also combine the characteristic of Chinese culture, be positive to adopt the new technologies and new methods according with the new century concept. Notice the combination of the social benefit and the commercial benefit to cultivate one good

individuated ecommerce image.

One good individuated and client-centered ecommerce image with the individuated marketing strategy of ecommerce can help the enterprises to maintain a long-term relatively regular customers, but also attract new user to join the consumption chain of the enterprise continuously. For example, environmental protection has become the hot and important topic of the 21<sup>st</sup> century. That the enterprise collects discarded batteries or presents one environmental can for collecting discarded batteries incidentally When delivering goods may be one nice peculiar marketing method which accords with new century concept. It can consider both social public welfare and the commercial benefit too. Another, when implementing electronic payment, we can retain some traditional payment means, such as cash payment on the spot, which accords with the long-term consumption culture of most Chinese people and satisfies some consumers by continuing their payment habit.

## 5. Conclusion

When one enterprise or one Internet website or one kind of service is client-centered, this always is regarded individuated and means larruping and will get more consumers' more attention. Individuated productions and individuated services have become the leading tide of ecommerce age. That Chinese enterprises construct their individuated ecommerce platform and develop individuated ecommerce is the effective strategy which replies the challenge aroused by the individuating trend of consumption and ecommerce, help the enterprise to bring into full play of ecommerce while avoiding venture and bring back one material repay. This also is one feasible way which helps Chinese enterprises subsist, develop, boost up in the more and more competitive market and gain one preponderant position. One good news is that some Chinese enterprises have begun to do some works in pursuit of developing client-centered ecommerce for adapting to the individuating trend of consumption and ecommerce with the client-centered concept. For example, when the consumer logon the ecommerce system which is set up by Digital-china Corp. of Legend Group, one characteristic homepage will come forth. If the consumer is a registered user, the ecommerce system will display the peculiar homepage made just for this user and provide him individuated one to one services. This also shows Digital-china Corp. is establishing the fundamental strategic concept which consumers are first and the center.

On the other hand, the enterprise shouldn't go from one extreme to the other too. This is said that the enterprise shouldn't pursue the individuality blindly and regard it as the target, the key point is client-centered and suit for clients' demands.

## References

[1] Deng Shoupeng. "The development and developing trend of electronic commerce in china", Science & Technology Industry

of China, 2001,3(6),24-27(in Chinese).

[2] Zhang Guoqing. "The individuated ecommerce and the individuating trend of ecommerce", EDI and ecommerce of AMT, ec\_individuation\_0918.htm (in Chinese).

[3] Gordlin Jaap & Akkermans, "Value based requirements creation for electronic commerce applications", Proceedings of the Hawaii International Conference on System Sciences, 2000,Jan 4-Jan 7,143 1060-3425(in English).

# Dynamic Pattern Matching Using Temporal Data Mining for Demand Forecasting

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## Abstract

Traditional time series methods are designed to analyze historical data and develop models to explain the observed behaviors and then predict future value(s) through the extrapolation from the models. The underlying premise is that the future values should follow the path of the historical data analyzed by the time series methods, and as such, these methods necessitate a significant amount of historical data to validate the model. However, this assumption may not make sense for applications, such as demand forecasting, where the characteristics of the time series may alter frequently because of the changes of consumers' behavior and/or cooperate strategies such as promotions. As the product life cycle gets shorter as it tends to be in today's e-business, it becomes increasingly difficult to make a forecast using traditional time series methods. In response to this challenge, this paper proposes a novel pattern matching procedure to decide whether one or combination of several patterns actually represents the development of the time series and then to use the patterns in forecasting. Several pattern transformation algorithms are also proposed to facilitate a flexible match. Rematching through dynamic reevaluation of the new data may be needed until the true development of the time series is discovered. Initial evaluation indicates superior performance in predicting the demand of a new product.

## 1. Introduction

Demand forecasting has attracted increasing attention because an accurate prediction of future demand dictates the success of supply chain planning. Various forms of demand forecasting techniques have been proposed in the literature including statistical approaches, decomposition methods and approaches borrowed from artificial intelligences. Statistical techniques, such as moving average (MA), autoregressive (AR) or integration of both methods i.e., auto regressive intergraded moving average (ARIMA) [2] regard times series as stochastic processes. Decomposition methods, such as Fourier transformation, convert the original time series into components in both time and frequency domains, and then predictions are applied to the individual components. In practice, simple methods such as moving average and exponential smoothing are frequently used due to their simplicity. Ironically, these simple methods might occasionally lead

to more accurate forecasting results than sophisticated or complex methods. Recently, techniques in the area of artificial intelligence, such as neural networks and genetic algorithms [4, 5, 7], became popular in time series forecasting. However, all the traditional time series forecasting methods are established under the assumption that certain "behavior" exists in the time series that can be modeled systematically with past history. Even though researchers claim neural network as a "model-free" approach, the technique still relies on selected time series data to predict future events. Such methods would not be able to predict the "turning point", or detect sudden behavioral changes.

Almost all the methods require a significant amount of past historical data to build or "train" the model. The validity of the model would be doubtful when only very short history of time series is available. A good example is that, the life cycle of consumer products has become much shorter than ever before due to changes in business paradigm from mass production to semi-customization. As a result, a lot of products did not have long historical records to make a demand forecast with traditional forecasting methods.

The paper presents a pattern-matching algorithm for time series forecasting, especially in demand forecasting when very short history of time series is available. The objective is to take advantage of new methodologies in the field of temporal data mining and apply them to forecasting. Section two presents the new pattern-matching algorithm. Section three presents an experimental evaluation in demand forecasting of a new product using the pattern-matching algorithm. Section four presents the conclusions and future research.

## 2. Pattern Matching in Time Series Forecasting

A vast amount of literature exists on detecting meaningful patterns in data mining and other domains. Both technical analysis and programming generated methods of detecting patterns have been proposed. However, the purpose of pattern matching in those studies is to find a good match of specific patterns "inside" a time series. Examples of researches in pattern matching include pattern recognition [8] and the similarity measurement [1, 3, 6]. While the basic concept of the proposed pattern-matching algorithm for forecasting is

that the meaningful patterns would repeat itself in the future of the time series. Therefore we only consider if a certain pattern is developing at the end of the time series. In other words, we treat the patterns not in the context of discovering higher-level relations of what they mean but use the patterns as possible representations of future values for the time series. The main purpose our pattern matching is to decide whether a pattern would actually represent the development of an on-going time series.

The idea of the proposed forecasting method originates from the concept that humans use available patterns to predict the future. Hence, we consider the followings steps as possible procedures for pattern matching in time series forecasting:

- (1) Match patterns at the end of the time series only. The purpose is to predict future value. The way the patterns exist in the (past) times series is not important;
- (2) Start by guessing and matching “partial” patterns. Only the front part of the patterns, which represents the portion of the pattern that has already occurred, is matched into the time series. The remainder or the “unmatched” portion of the pattern is used as forecasts of future values.
- (3) Consider several candidates before a good match is completed. There might be several candidates of patterns at the beginning of the forecasting process. The true, or closest pattern that represents the on-going time series may not be revealed at the beginning but will be identified as the process is continued. In some cases, a combination of several patterns may be the best way to characterize the on-going time series. Hence, a weighting scheme would be necessary to make an overall forecast from different patterns. Re-evaluation is needed as the new data of the time series arrives.
- (4) Adjust patterns to fit the time series. Transformations of pattern may be needed to increase the precision of the pattern matching as well as the forecasting accuracy.

Note that it is not obligatory to obtain the patterns directly from the historical data of the same time series. For example, in the case of demand forecasting of a new product or the life cycle of the product is too short to extract meaningful patterns and assuming that the company had produced similar items in the past, the demand patterns of the old products might be very good indicators for the new product. This suggests a way to forecast a short time series in such a special case (i.e., use patterns found in other time series).

An important assumption of the proposed matching algorithm is that the current time series is developing into a trend that is equal or similar to an interesting pattern and we have several possible candidates of the pattern at hand. The problem is then reduced to find which pattern or combination of patterns will be best to represent the immediate future of the time series.

Based on the above analysis, we propose the following algorithm:

Pre-condition: time series  $x$ , candidate patterns  $y$ .

Post condition: forecasted future values  $x\hat{c}$ .

1. Apply the matching algorithm to each pattern. (Matching algorithm is stated in section 2.1)
2. Decide the candidate set of patterns and the weights for each pattern (Weighting scheme is stated in section 2.2). The overall forecast is the weighted sum of forecasts from the patterns.
3. Update mean square error (MSE) for each pattern when new data arrives. If the updated MSE's indicated a better match or one or more of the candidate patterns were exhausted, repeat step (1) and iterate Step (2). Otherwise, advance the time index, report the new forecasts with the same set of patterns and their weights.

## 2.1 Matching Algorithm

From the discussion in the previous section, we propose the matching algorithm in this section. For us to find the best matching for the pattern, we need to define how well the patterns will fit at the end of the time series. The similarity measure used in this study is mean square error (MSE). MSE was chosen in this study because patterns may not match to the same depth for each pattern. If measures such as total sum of square were used to estimate the forecasting accuracy, the result would be biased by the length that individual pattern matched to the time series. The objective of the proposed matching algorithm is to find the best match with the minimum MSE. The pattern-matching algorithm is described as follows.

Given: Time series  $x = \{x(0), x(-1), x(-2), x(-3), \dots\}$   
 /\*  $x(t)$  indicate the past history at time  $t$ . \*/  
 /\*  $t=0$  indicates current time \*/  
 Pattern:  $\{y(0), y(1), y(2), \dots, y(n)\}$   
 /\* length of the pattern =  $n$  \*/

Output:  $optm$ , number of period used in the pattern that generate the best MSE;  $opt$  = the best MSE, and forecasts  $\{x'(1), x'(2), x'(3), \dots, x'(n-optm)\}$

```

begin
  optm= 3;      /*starting with a 3-point match to
                avoid over-fitting*/
  opt = 10000; /* initializing with a large
                number*/

  for m= 3 to n-1 do
    /* m indicates the matching depth */
    begin
      mse=10000; /* initializing with a large
                  number*/
      for k = 1 to m do
        mse=(x(-k+1)-y(m-k))^2;
        mse=mse/m;

        if mse <= opt;
          begin
            optm=m;
  
```

```

    opt=mse;
  end
end

for j=1 to (n-optm) do
  x'(j) = y(optm+j);
  /* reporting the remainders of the */
  /* pattern as forecasts*/
  output optm, opt, x';
end

```

An example of matching depths (m) 4 and 5 of a pattern into a time series is illustrated in Figure 1. The matching depth of 4 indicated the first 4 data points in the pattern ( $y_0, y_1, y_2$  and  $y_3$ ) which are compared with the last 4 data points in the time series ( $x_{-3}, x_{-2}, x_{-1}$  and  $x_0$ ). The MSE of matching depth of 4 is calculated as the average of the squared difference of the 4 paired data points. The construction of the MSE for matching depth of 5 would follow a similar definition. As shown in Figure 1,  $m = 4$  has a smaller MSE than  $m = 5$ . If  $m = 4$  has the smallest MSE,  $y_4, y_5, \dots$  will be reported as forecasts of the future values. In the next iteration, i.e. when new data arrives, the MSE will be updated. If the updated MSE is within the threshold,  $y_5, y_6, \dots$  will be reported as forecasts. Otherwise, a "rematch" will be performed for this pattern by using the proposed matching algorithm.

obtain an overall forecast. In the literature on combining forecasts, researchers proposed various ways of assigning weights to different forecasting methods. However, most of the methods employ mathematical procedures such as quadratic programming that requires all the methods to be examined over the same period of time. In the proposed pattern matching forecasting, the matching depths of patterns may not be the same; hence the quadratic programming is not applicable. Instead, we proposed a simple weight-assigning procedure in order to decide how well the pattern fit into the time series.

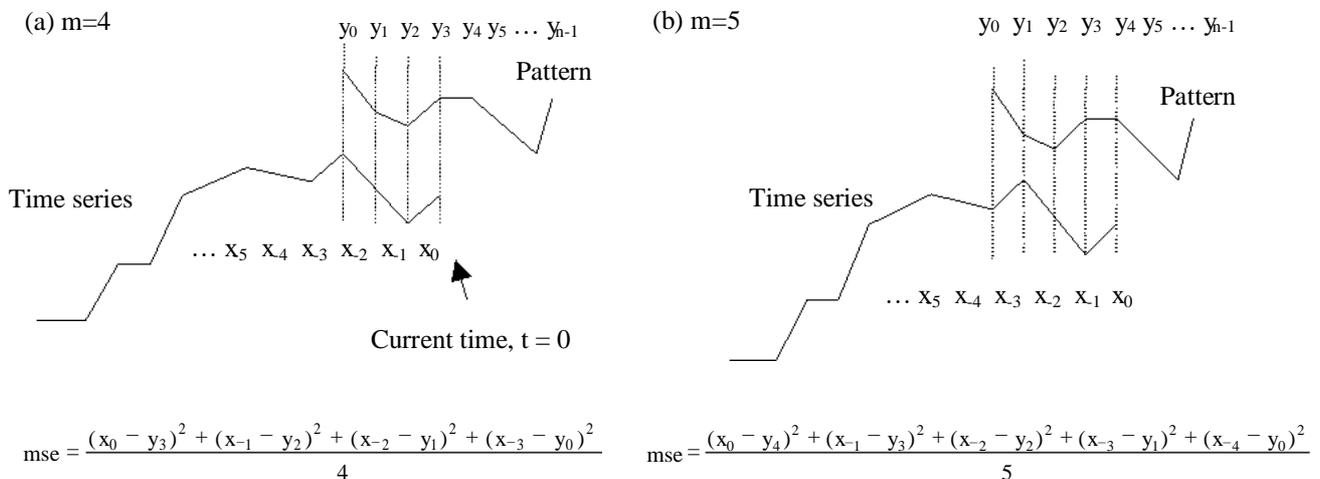
The MSE for each pattern is used to evaluate the performance of the pattern, and thus, will be used to decide the weight assigned to the pattern. Not all of the patterns are included in the overall forecast. A threshold value  $m^*$  is first determined to select the candidate patterns. A candidate pattern is the one whose minimum MSE is less than  $m^*$ . The weight assignment for each pattern is then proposed as follows.

$$w_i = \frac{m^* - mse_i}{\sum_{i \in C} (m^* - mse_i)} \text{ for all } i \in C;$$

$$w_i = 0 \text{ otherwise.} \quad (1)$$

where  $w_i$  is the weight for candidate pattern  $i$ ,  $mse_i$  is the MSE for candidate pattern  $i$  and  $C$  is the index set for the candidate patterns.

For example, assume that we choose the threshold,  $m^*$



Where  $x$  = time series data at time  $t$  with current time  $t$  equal to 0  
 $y_i$  = pattern data in a relative time index  $i = 0, 1, 2, \dots, n$ .  
 $n$  = length of the pattern

Figure 1. Illustrated calculation of mse with pattern matching depth  $m= 4$  and  $5$ . (Patterns were lifted for better demonstration).

## 2.2 Weighting Scheme

In the case of using several candidate patterns to perform the forecasting, a weighting scheme would be necessary to combine the forecasts of the patterns and

$= 5$ , the MSE's are 6, 4, 2.5, 7, and 1 for patterns  $i = 1, 2, \dots, 5$ , respectively. Then patterns 2, 3 and 5 will be the candidate patterns since their MSE's are lower than 5. Their weights can be calculated as follows:  $w_2 =$

$1/(1+2.5+4)=0.1333$ ,  $w_3 = 2.5/(1+2.5+4)=0.3333$ ,  $w_5 = 4/(1+2.5+4)=0.5333$ . Weights  $w_1$  and  $w_4$  will both be zero because the MSE's for patterns 1 and 4 are larger than  $m^*$ . Note that pattern 5 has the largest weight for having the smallest MSE among the patterns. If the reported forecasts are 45, 36, 47, 52, and 67 from the five patterns, the overall (weighted) forecast would be  $45 \times 0 + 36 \times 13.33\% + 47 \times 33.33\% + 52 \times 0 + 67 \times 53.33\% = 56.2$ .

The weights are adjusted dynamically to improve forecasting accuracy. Since the MSE for each pattern will likely be different when the new data arrives, the candidate set and the assigned weights need to be re-evaluated to reflect the best combination of the overall forecast. In the above example, we will still keep patterns 1 and 4 and their predictions because there might come a time when they would make a better forecast. In other words, once their MSE's become smaller than  $m^*$ , they can be included in the candidate set. This dynamic re-evaluation of weights makes the proposed pattern-matching algorithm possible to facilitate potential changes in characteristics of the time series.

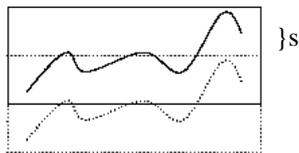
### 2.3 Transformation of Patterns

Transformation of a pattern are needed to lower the MSE for the reason that the time series may be developing similarly to but not exactly the same as the pattern. We would like the pattern-matching algorithm to be flexible and able to deal with scaling and time axis distortion problems. Techniques such as dynamic time wrapping (DTW) have been used in regular pattern matching inside a time series [1, 6]. However, they are not applicable to the forecasting algorithm proposed in this study. The reason is that only a partial pattern is used in our matching algorithm, while DTW requires two full patterns. Hence, the following pattern transformations are proposed.

(1) Vertical Shift --

$$y'_i = y_i + s, \quad (2)$$

where  $s$  is the displacement in the vertical direction. ' $s$ ' could be either positive or negative to represent a shift up and/or down respectively. Horizontal shift is not required because of the way pattern fits into the time series covers the horizontal shift.

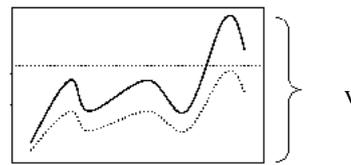


(2) Vertical extension/compression --

$$y'_i = \min_i y_i + v \left( \frac{y_i - \min_i y_i}{\max_i y_i - \min_i y_i} \right), \quad (3)$$

where  $v$  is the ratio the whole pattern extends vertically. (See appendix A for detailed derivation) If  $v < 1$ , this indicates a compression whereas if  $v > 1$ , indicates an

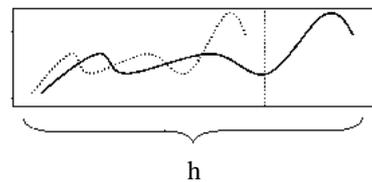
extension.



(3) Horizontal extension/compression – the way to calculate a horizontal extension is more complex than the calculation for a vertical one. First, we need to reconstruct a new time index  $i' = 1, 2, 3, \dots [nh]$  where  $h$  is the ratio of the whole pattern extending horizontally,  $n$  is the length of the pattern, and  $[nh]$  is the largest integer less than or equal to  $nh$ .

$$\begin{aligned} \text{Then } y'_{i'} &= \text{Interpolation of } y_i \text{ and } y_{i+1} \\ &\text{where } h i' \leq i' < h(i+1) \\ &= y_i + (i' - hi)/h \times (y_{i+1} - y_i) \end{aligned} \quad (4)$$

(See appendix B for detailed derivation)



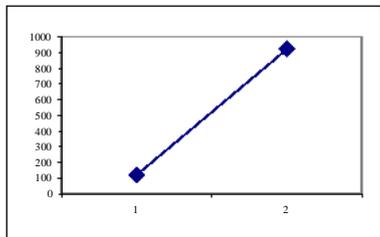
(4) Combination of the above transformations

Transformation(s) should be applied to the pattern prior to the matching algorithm. The optimal transformations ( $s$ ,  $v$  and/or  $h$ ) may be decided by using mathematical programming. In demand forecasting, the transformation in horizontal direction may not be much realistic because of the seasonality issue of product sale. Therefore, the combination of shift and vertical extension/compression will be the two main transformations in the application on of demand forecasting. A heuristic procedure to find  $s$  and  $v$  is (1) shifting the pattern so that the mean value of the selected data points in pattern is equal to the mean value of the matched data points in time series; then (2) finding  $v$  that generates the minimum MSE.

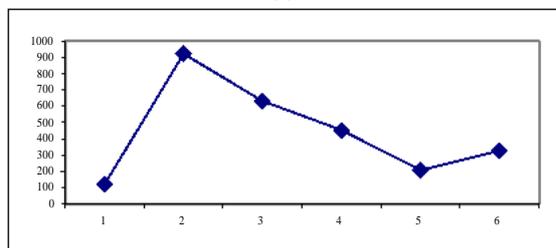
### 3. Experimental Evaluation

As mentioned in the previous section, the transformation of today's business focus from mass production to semi-customization shortens a product's life cycle and makes demand forecasting difficult. This is especially true when a new product enters the market, because there is no historical data available to make a forecast. However, the proposed pattern matching procedure still generates reasonable predictions since patterns were extracted from the past sales of similar products and/or predictions from human experts.

To demonstrate the usefulness of the proposed pattern matching procedure, we use a real world data set. All data are obtained from the same company where the demand forecasting of a new product X is desired. In particular, the sales data of the first two months of product X is collected (Figure2 a). The past sales data of four similar products (products O, Q, R and U) are used as patterns (Figure3) to predict the future demand of product X.



(a)



(b)

Figure 2. The actual demand of product X during (a) first two months (b) the first 6 months.

As shown in Figure 3, most of the sale patterns consist of an immediate surge of sales shortly after the products were introduced to the market due to their promotion, then the demand subsides soon after the new product's introduction. Those patterns look similar, but have their own characteristics. What differentiates the patterns are the customers' reaction to the promotion of the new products and how the products were accepted by the customers. The purpose for this case study is to examine if the development of product X is similar to those patterns, in fact, we use the combination of those patterns to predict the future demand of product X.

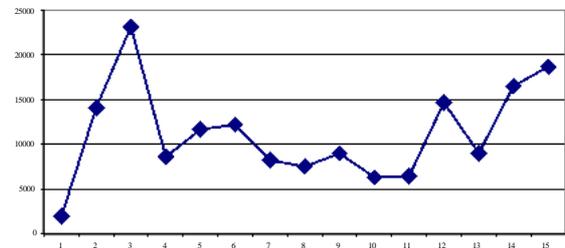
In our example, month 2 will be the current time, which is noted as  $t_0$ . We attempt to predict month 3 ( $t_1$ ), 4 ( $t_2$ ), 5( $t_3$ )... etc. Forecasted and actual values will be denoted as  $x_i'$  and  $x_i$ , respectively, with an appropriate time index.

Notice that we only have two data points of product X (120 and 921) at the beginning of the experiment, almost all the existing forecasting methods is not applicable to such a short time series. One can only "guess" that the value for the third month will either follow the linear trend from the first two months, i.e.  $x_1' = 921 + (921 - 120) = 1722$ , or average the sales of the first two months i.e.  $x_1' = (120 + 921) / 2 = 520.5$ . Apparently, neither would be a reasonable forecast because judging from the sale patterns of products O, Q, R and U, there might be a turning point in month 2 ( $t_0$ ) or 3 ( $t_1$ ). But, we will apply the matching algorithm and let the procedure decide what the turning

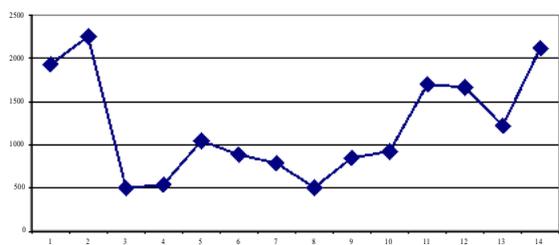
point should be, by finding the best matches using the matching algorithm.

The result of the matching is shown in Table 1. As

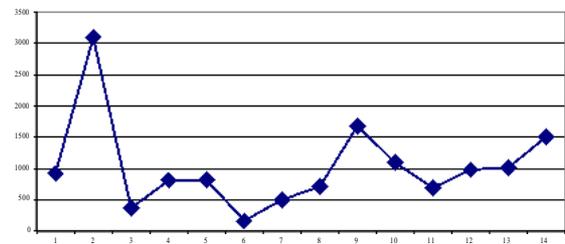
Product O



Product Q



Product R



Product U

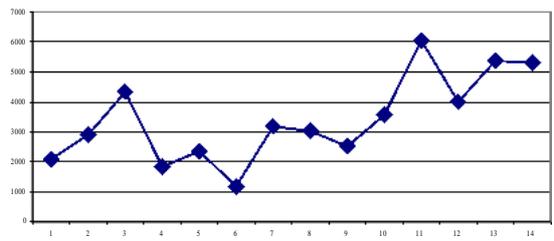


Figure 3. Sale patterns of products O, Q, R and U that were used to predict the future demand of product X

shown in Table 1, the weights were assigned equally at the first month, because there were no historical performance evaluations for the patterns. Starting at month 4 and continuing to month 8, the weights for patterns of products O and R are heavier than the other two products. If we examine the patterns and the overall development of product X (Figure 2(b)), we can easily tell that product X's on-going sale pattern is more comparable to products O and R than those of products Q and U. In other words, the patterns of two products that show more closer resemblances to product X receive heavier weights.

Table 1. Forecasts with patterns of past sales products, corresponding weights and over all forecast for product X

	Month					
	3	4	5	6	7	8
Forecast						
product O	1320.4	339.69	395.49	374.80	245.23	222.23
product Q	0	451.41	428.61	344.43	313.20	277.36
product R	0	260.63	319.63	161.00	209.35	222.30
product U	2121.4	677.57	366.71	107.26	450.10	382.78
Weights						
product O	25%	59.94%	33.04%	29.70%	28.11%	28.95%
product Q	25%	4.24%	14.05%	14.90%	17.23%	18.56%
product R	25%	21.46%	29.94%	31.11%	29.95%	30.97%
product U	25%	14.36%	22.97%	24.28%	24.72%	21.52%
Overall Forecast	860.44	375.97	370.82	238.79	296.83	267.03

The comparison of predictions and the actual demand for up to month 8 are listed in Table 2. In Table 2, we also compare our result with the predictions made by the exponential smoothing method. The exponential smoothing method was selected because all the other methods, such as ARIMA and neural networks, would require much more data to create or train a model. Exponential smoothing and simple moving averaging are the only two choices available for such a short past history. Exponential smoothing is preferred over the simple moving averaging method in terms of better forecasting accuracy. The values shown for months 3-7 for the exponential methods are fitted value; the only forecast value is the one for month 8. The RMSE (root mean squared errors) of the forecast for both methods are listed. The graphic representation of how the two systems performed in predicting product X is depicted in Figure 4. Apparently, the proposed pattern matching procedure has outperformed exponential smoothing, which is the only traditional forecasting method available to predict a time series with such a short history.

Table 2. Comparison of forecasts with pattern matching and exponential smoothing.

	Month					
	3	4	5	6	7	8
Actual	632	453	208	327	220	374
Forecast: Pattern Matching	860.4	376.0	370.8	238.8	296.8	267.0
Exponential Smoothing	395.5	425.1	428.6	401.0	391.8	370.3
Note	RMSE for Pattern Matching is 140					
	RMSE for Exponential smoothing is 281					

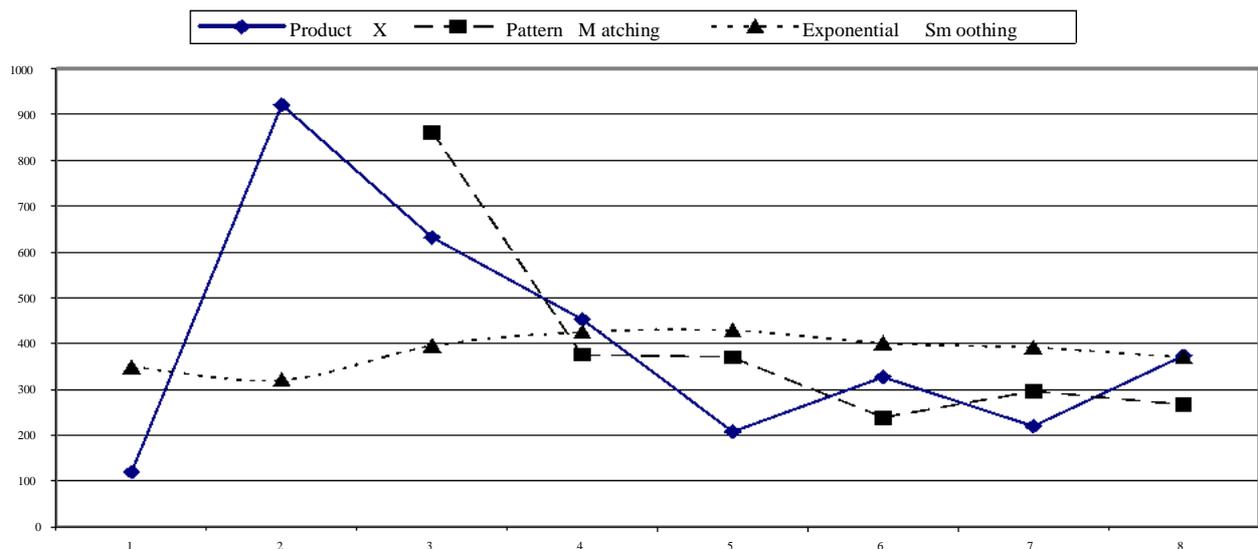


Figure 4. Comparison of pattern matching and exponential smoothing.

#### 4. Conclusion

This paper has presented a novel approach to demand forecasting that is designed for pattern matching. Patterns could be defined by human experts or extracted from various data mining techniques. In our example, instead of creating models from the immediate past history to predict future values, the past sales of similar products were used as predictors of the sale of the product examined. Initial evaluation indicates superior performance in predicting demand of a new product. With little demand data available for the new product, most existing methods are not even applicable to create valid models for demand forecasting.

Although it is not the focus of this study, the presence of “quality” patterns to forecast is essential for this approach. Nevertheless, the approach provides an alternative way of forecasting and beefs up some weakness of the traditional methods. It may be used in conjunction with other forecasting methods to improve overall forecasting results and to apply the pattern matching procedure to a wide range of forecasting problems. In fact, the proposed dynamic pattern-matching algorithm is part of the architecture of an agent-based forecasting system [10]. The purpose is to capture the uncertainty that exists in temporal data sets and apply advanced data mining technique to improve forecasting accuracy.

#### Appendix - Derivation of Transformation Equations

##### A. Vertical extension/compression

let  $y_i$  denote the original pattern at time  $i$ ,  $y'_i$  denote the transformed pattern at time  $i$

let  $v$  be the ratio of the whole pattern extends vertically from the bottom of the pattern

$$\Rightarrow \min_i y_i \text{ remain the same, i.e. } \min_i y'_i = \min_i y_i,$$

while  $\max_i y_i$  extend up to a ratio of  $v$  i.e.  $\max_i y'_i =$

$$\min_i y'_i + (\max_i y_i - \min_i y_i) \times v$$

$\Rightarrow$  for any  $y_i$ ,  $y_i$  extend up to a ratio of  $(y_i - \min_i y_i)$

$$/(\max_i y_i - \min_i y_i) \times v$$

$$\text{i.e. } y'_i - \min_i y'_i = (y_i - \min_i y_i) / (\max_i y_i - \min_i y_i) \times v$$

$$\Rightarrow y'_i = \min_i y'_i + (y_i - \min_i y_i) / (\max_i y_i - \min_i y_i) \times v$$

##### B. Horizontal extension/compression

let  $y_i$  denote the original pattern at time  $i$ ,

$y'_i$  denote the transformed pattern at time  $i$   
 $n$  denote the length of the pattern.

let  $h$  be the ratio of the whole pattern extends horizontally from the beginning of the pattern

$\Rightarrow y_i$  will map to the new domain set of  $\{h, 2h, 3h, \dots, nh\}$

Since the element of the new domain set may not necessary be integer, which is not eligible to be a time index set, a new time index set  $I'$  will be defined as  $\{1, 2, 3, \dots, [nh]\}$ . Where  $[nh]$  is the largest integer that less than or equal to  $nh$ .

$\Rightarrow y'_i$  will become the new range set that the time index set  $I'$  maps into.

$$\Rightarrow y'_{i'} = \text{Interpolation of } y \text{ and } y_{i+1} \\ \text{where } h \leq i' < h(i+1)$$

$$\Rightarrow (y'_{i'} - y_i) / (y_{i+1} - y_i) = (i' - ih) / ((i+1)h - ih)$$

$$\Rightarrow y'_{i'} = y + (y_{i+1} - y_i) \times (i' - ih) / h$$

#### References

- [1] Berndt D. J. and J. Clifford, “Finding Patterns in Time Series: A Dynamic Programming Approach,” in U. M. Fayyad, G. Piatetsky-Shapiro, P. Smyth and R. Uthurusamy (Eds.), *Advances in Knowledge Discovery and Data Mining*, AAAI Press/The MIT Press, Menlo Park, California, pp229-248, 1996
- [2] Chatfield C., “Time-Series Forecasting,” Boca Raton: Chapman and Hall, 2001
- [3] Gunopulous, D. and G. Das, “Time Series Similarity Measures,” Tutorial Notes for ACM SIGKDD 2000, pp 245-307, 2000
- [4] Hill, T., M. O'Connor and W. Remus, "Neural Network Models for Time Series Forecasts" *Management Science*, 42:7, pp 1082-92, 1996
- [5] Kao, R. J., "A Sale Forecasting System Based on Fuzzy Neural Network with Initial Weights Generated by Genetic Algorithm," *European Journal of Operational Research*, 129, pp 496-517, 2001
- [6] Keogh, E. and Pazzani, M., "Scaling up Dynamic Time Warping for Datamining Applications," *Proceedings of the sixth ACM SIGKDD International Conference on Knowledge Discovery and Data Mining*, pp 285-89, 2000
- [7] Lee, K. C. and S. B. Oh, "An Intelligent Approach to Time Series Identification by a Neural Network-driven Decision Tree Classifier," *Decision Support System*, 17 pp 183-97, 1996
- [8] Morrill, J. P., "Distributed Recognitions of Patterns in Time Series Data" *Communications of the ACM*, 41:5, pp 45-51, 1998
- [9] Antunes, C. M. and A. L. Oliveria, "Temporal Data Mining: an overview," *Proceedings of the seventh ACM SIGKDD International Conference on Knowledge Discovery and Data Mining, Workshop on Temporal Data Mining*, August 26, 2001
- [10] Yu, W. and J. H. Graham, "A MultipleAgent Architecture for Demand Forecasting in Electronic Commerce Supply Chain System," *Proceedings of the 17th International Conference on Computers and Their Applications (CATA-2002)*, pp. 462-66, April 2002

# A Mining Algorithm under Fuzzy Taxonomic Structures

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## Abstract

Most conventional data-mining algorithms identify the relationships among transactions using binary values and find rules at a single concept level. Transactions with quantitative values and items with taxonomic relations are, however, commonly seen in real-world applications. Besides, the taxonomic structures may also be represented in a fuzzy way. This paper thus proposes a fuzzy multiple-level mining algorithm for extracting fuzzy association rules under given fuzzy taxonomic structures. The proposed algorithm adopts a top-down progressively deepening approach to finding large itemsets. It integrates fuzzy-set concepts, data-mining technologies and multiple-level fuzzy taxonomy to find fuzzy association rules from given transaction data sets. Each item uses only the linguistic term with the maximum cardinality in later mining processes, thus making the number of fuzzy regions to be processed the same as the number of the original items. The algorithm therefore focuses on the most important linguistic terms for reduced time complexity.

## 1. Introduction

Machine-learning and data-mining techniques have been developed to turn data into useful task-oriented knowledge [20]. Deriving association rules from transaction databases is most commonly seen in data mining [1][2][6][9][10][11][13][14][27][28]. It discovers relationships among items such that the presence of certain items in a transaction tends to imply the presence of certain other items.

Most previous studies have concentrated on showing how binary-valued transaction data may be handled. However, transaction data in real-world applications usually consist of quantitative values, so designing a sophisticated data-mining algorithm able to deal with quantitative data presents a challenge to workers in this research field.

In the past, Agrawal and his co-workers proposed several mining algorithms for finding association rules in transaction data based on the concept of large itemsets [1-2, 28]. They also proposed a method [27] for mining association rules from data sets using quantitative and categorical attributes. Their proposed method first determines the number of partitions for each quantitative attribute, and then maps all possible values of each

attribute onto a set of consecutive integers. Other methods have also been proposed to handle numeric attributes and to derive association rules. Fukuda et al. introduced the optimized association-rule problem and permitted association rules to contain single uninstantiated conditions on the left-hand side [11]. They also proposed schemes for determining conditions under which rule confidence or support values are maximized. However, their schemes were suitable only for single optimal regions. Rastogi and Shim extended the approach to more than one optimal region, and showed that the problem was NP-hard even for cases involving one uninstantiated numeric attribute [23][24].

Fuzzy set theory is being used more and more frequently in intelligent systems because of its simplicity and similarity to human reasoning [18]. Several fuzzy learning algorithms for inducing rules from given sets of data have been designed and used to good effect with specific domains [3-4, 8, 12, 15-17, 25, 29-30]. Strategies based on decision trees were proposed in [7, 21-22, 25, 31, 33], and Wang et al. proposed a fuzzy version space learning strategy for managing vague information [29]. Hong et al. also proposed a fuzzy mining algorithm for managing quantitative data [14].

In [18], we proposed a data-mining algorithm able to deal with quantitative data under a crisp taxonomic structure. In that approach, each item definitely belongs to only one ancestor in the taxonomic structure. The taxonomic structures may, however, not be crisp in real-world applications. An item may belong to different classes in different views. This paper thus proposes a new fuzzy data-mining algorithm for extracting fuzzy multiple-level association rules under given fuzzy taxonomic structures. The proposed algorithm adopts a top-down progressively deepening approach to finding large itemsets.

## 2. Review of Fuzzy Set Concepts

Fuzzy set theory was first proposed by Zadeh in 1965 [34]. Fuzzy set theory is primarily concerned with quantifying and reasoning using natural language in which words can have ambiguous meanings. This can be thought of as an extension of traditional crisp sets, in which each element must either be in or not be in a set.

Formally, the process by which individuals from a universal set  $X$  are determined to be either members or non-members of a crisp set can be defined by a

characteristic or discrimination function [34]. For a given crisp set A, this function assigns a value  $\mu_A(x)$  to every  $x \in X$  such that

$$\mu_A(x) = \begin{cases} 1 & \text{if and only if } x \in A \\ 0 & \text{if and only if } x \notin A \end{cases}$$

Thus, the function maps elements of the universal set to the set containing 0 and 1. This function can be generalized such that the values assigned to the elements of the universal set fall within specified ranges, referred to as the membership grades of these elements in the set. Larger values denote higher degrees of set membership. Such a function is called the membership function,  $\mu_A(x)$ , by which a fuzzy set A is usually defined. This function is represented by

$$\mu_A : X \rightarrow [0,1],$$

where  $[0, 1]$  denotes the interval of real numbers from 0 to 1, inclusive. The function can also be generalized to any real interval instead of  $[0,1]$ .

A special notation is often used in the literature to represent fuzzy sets. Assume that  $x_1$  to  $x_n$  are the elements in fuzzy set A, and  $\mu_1$  to  $\mu_n$  are, respectively, their grades of membership in A. A is then represented as follows:

$$A = \mu_1 / x_1 + \mu_2 / x_2 + \dots + \mu_n / x_n.$$

An  $\alpha$ -cut of a fuzzy set A is a crisp set  $A_\alpha$  that contains all elements in the universal set X with membership grades in A greater than or equal to a specified value  $\alpha$ . This definition can be written as:

$$A_\alpha = \{x \in X \mid \mu_A(x) \geq \alpha\}.$$

The scalar cardinality of a fuzzy set A defined on a finite universal set X is the summation of the membership grades of all the elements of X in A. Thus,

$$|A| = \sum_{x \in X} \mu_A(x).$$

Among operations on fuzzy sets are the basic and commonly used complementation, union and intersection, as proposed by Zadeh.

The complementation of a fuzzy set A is denoted by  $\neg A$ , and the membership function of  $\neg A$  is given by:

$$\mu_{\neg A}(x) = 1 - \mu_A(x), \quad \forall x \in X.$$

The intersection of two fuzzy sets A and B is denoted by  $A \cap B$ , and the membership function of  $A \cap B$  is given by:

$$\mu_{A \cap B}(x) = \min\{\mu_A(x), \mu_B(x)\}, \quad \forall x \in X.$$

The union of fuzzy sets A and B is denoted by  $A \cup B$ , and the membership function of  $A \cup B$  is given by:

$$\mu_{A \cup B}(x) = \max\{\mu_A(x), \mu_B(x)\}, \quad \forall x \in X.$$

The above concepts will be used in our proposed

algorithm to mine a set of fuzzy interesting association rules under fuzzy taxonomic structures.

### 3. Data Mining with a Fuzzy Taxonomic Structure

Previous studies on data mining focused on finding association rules on a single-concept level. Mining multiple-concept-level rules may, however, lead to discovery of more general and important knowledge from data. Relevant taxonomies of data items are thus usually predefined in real-world applications. An item may, however, belong to different classes in different views. When taxonomic structures are not crisp, hierarchical graphs can be used to represent them. Terminal nodes on the hierarchical graphs represent the items actually appearing in transactions; internal nodes represent classes or concepts formed by lower-level nodes. A simple example is given in Figure 1.

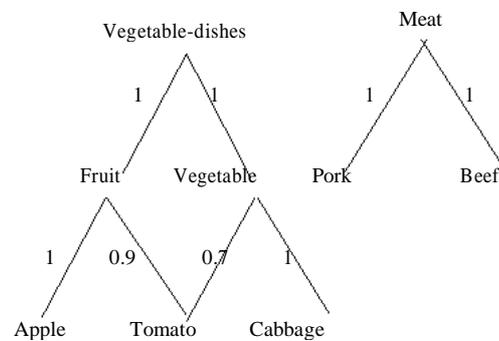


Figure 1. An example of fuzzy taxonomic structures

In this example, vegetable dishes fall into two classes: fruit and vegetable. Fruit can be further classified into apple and tomato. Similarly, assume vegetable is divided into tomato and cabbage. Note that tomato belongs to both fruit and vegetable with different membership degrees. It is thought of as fruit with 0.9 membership value and as vegetable with 0.7. The membership value of tomato belonging to vegetable dishes can be calculated using the max-min product combination. Since both fruit and vegetable belong to vegetable dishes with membership value 1, the membership value of tomato belonging to vegetable dishes is then  $\max(\min(1, 0.9), \min(1, 0.7))=0.9$ . Only the terminal items (apple, tomato, cabbage, pork and beef) can appear in transactions. The membership degrees of ancestors for each terminal node are shown in Table 1.

Wei and Chen proposed a method to find generalized association rules under fuzzy taxonomic structures [32]. The items to be processed in their approach are binary. Their mining process first calculated the membership values of ancestors for each terminal node in the manner mentioned above. Han and Fu also proposed a method for finding level-crossing association rules at multiple levels [13]. In that method,

Table 1. The membership degrees of ancestors for each terminal node in this example

Terminal node	Membership values of ancestors
Apple	1/Fruit, 1/Vegetable-dishes
Tomato	0.9/Fruit, 0.7/Vegetable, 0.9/Vegetable-dishes
Cabbage	1/Vegetable, 1/Vegetable-dishes
Pork	1/Meat
Beef	1/Meat

each item only belongs to one ancestor in the preceding generation. A top-down progressively deepening search approach is used. Their method finds flexible association rules not confined to strict, pre-arranged conceptual hierarchies and exploration of “level-crossing” association relationships is allowed. Candidate itemsets on certain levels may thus contain other-level items. For example, candidate 2-itemsets on level 2 are not limited to containing only pairs of large items on level 2. Instead, large items on level 2 may be paired with large items on level 1 to form candidate 2-itemsets on level 2.

Wei and Chen’s concepts of fuzzy taxonomic structures and Han and Fu’s top-down progressively deepening search approach were used in our approach to mine fuzzy generalized association rules from quantitative transaction data. The rules mined are expressed in linguistic terms, which are more natural and understandable for human beings.

#### 4. Notation

The following symbols are used in our proposed algorithm:

- $n$ : the number of transactions;
- $D_i$ : the  $i$ -th transaction,  $1 \leq i \leq n$ ;
- $x$ : the number of levels in a given taxonomy.
- $m^k$ : the number of items (nodes) at level  $k$ ,  $1 \leq k \leq x$  ;
- $I_j^k$ : the  $j$ -th item on level  $k$ ,  $1 \leq k \leq x$ ;  $1 \leq j \leq m^k$ ;
- $h_j^k$ : the number of fuzzy regions for  $I_j^k$  ;
- $R_{jl}^k$ : the  $l$ -th fuzzy region of  $I_j^k$ ,  $1 \leq l \leq h_j^k$  ;
- $v_{ij}^k$ : the quantitative value of  $I_j^k$  in  $D_i$  ;
- $f_{ij}^k$ : the fuzzy set converted from  $v_{ij}^k$  ;
- $f_{ijl}^k$ : the membership value of  $D_i$  in region  $R_{jl}^k$  ;
- $\text{count}_{jl}^k$ : the summation of  $f_{ijl}^k$ ,  $i=1$  to  $n$ ;
- $\text{max-count}_j^k$ : the maximum count value among  $\text{count}_{jl}^k$  values,  $l=1$  to  $h_j^k$  ;
- $\text{max-R}_j^k$ : the fuzzy region of  $I_j^k$  with  $\text{max-count}_j^k$  ;
- $\alpha$ : the predefined minimum support value;
- $\lambda$ : the predefined minimum confidence value;
- $C_r^k$ : the set of candidate itemsets with  $r$  items on

level  $k$ ;

$L_r^k$ : the set of large itemsets with  $r$  items on level  $k$ .

#### 5. The Multiple-level Fuzzy Data-mining Algorithm

The proposed mining algorithm integrates fuzzy set concepts, data mining and multiple-level fuzzy taxonomy to find fuzzy association rules in a given transaction data set. The knowledge derived is represented by fuzzy linguistic terms, and thus easily understandable by human beings.

The proposed fuzzy mining algorithm first calculates the membership values of ancestors for each terminal node as Wei and Chen’s method did. It then adopts a top-down progressively deepening approach to finding large itemsets. Each item uses only the linguistic term with the maximum cardinality in later mining processes, thus making the number of fuzzy regions to be processed the same as the number of original items. The algorithm therefore focuses on the most important linguistic terms, which reduces its time complexity. A mining process using fuzzy counts is performed to find fuzzy multiple-level association rules. Details of the proposed fuzzy mining algorithm are stated below.

The fuzzy mining algorithm using taxonomy:

INPUT: A body of  $n$  quantitative transaction data, a set of membership functions, predefined fuzzy taxonomic structures, a predefined minimum support value  $\alpha$ , and a predefined confidence value  $\lambda$  .

OUTPUT: A set of fuzzy multiple-level association rules.

STEP 1: Set  $k=1$ , where  $k$  is used to store the level number being processed.

STEP 2: Calculate the membership values of ancestors of each terminal node from the given fuzzy taxonomic structure.

STEP 3: Calculate the quantitative value  $v_{ij}^k$  of each ancestor item  $I_j^k$  in transaction datum  $D_i$  ( $i=1$  to  $n$ ) as:

$$v_{ij}^k = \sum_{v_{ij}^x \text{ in } D_i} v_{ij}^x * \mu_{I_j^k}(I_{ij}^x)$$

where  $I_{ij}^x$  is a terminal item appearing in  $D_i$ ,  $v_{ij}^x$  is the quantitative value of  $I_{ij}^x$ , and  $\mu_{I_j^k}(I_{ij}^x)$  is the membership value of item  $I_{ij}^x$  belonging to ancestor  $I_j^k$  .

STEP 4: Count the number of occurrences of each ancestor item  $I_j^k$  in the transactions and remove the each ancestor item  $I_j^k$  with their counts less than  $\alpha$  .

STEP 5: Transform the quantitative value  $v_{ij}^k$  of each transaction datum  $D_i$  ( $i=1$  to  $n$ ) for each  $I_j^k$  into a fuzzy set  $f_{ij}^k$  represented as:

$$\left[ \frac{f_{ij1}^k}{R_{j1}^k} + \frac{f_{ij2}^k}{R_{j2}^k} + \dots + \frac{f_{ijh}^k}{R_{jh}^k} \right]$$

by mapping  $v_{ij}^k$  form the given membership functions, where  $h$  is the number of fuzzy regions for  $I_j^k$ ,  $R_{jl}^k$  is the  $l$ -th fuzzy region of  $I_j^k$ ,  $1 \leq l \leq h$ , and  $f_{ijl}^k$  is  $v_{ij}^k$ 's fuzzy membership value in region  $R_{jl}^k$ .

STEP 6: Calculate the scalar cardinality of each fuzzy region  $R_{jl}^k$  in the transaction data:

$$\text{count}_{jl}^k = \sum_{i=1}^n f_{ijl}^k.$$

STEP 7: Find  $\max - \text{count}_j^k = \text{MAX}_{j=1}^{m^k} (\text{count}_{jl}^k)$ , for  $j=1$  to  $m^k$ , where  $h_j^k$  is the number of fuzzy regions for  $I_j^k$  and  $m^k$  is the number of items (nodes) on level  $k$ . Let  $\max - R_j^k$  be the region with  $\max - \text{count}_j^k$  for item  $I_j^k$ , which will be used to represent the fuzzy characteristic of item  $I_j^k$  in later mining processes.

STEP 8: Check whether the value  $\max - \text{count}_j^k$  of a region  $\max - R_j^k$ ,  $j=1$  to  $m^k$ , is larger than or equal to the predefined minimum support value  $\alpha$ . If a region  $\max - R_j^k$  is equal to or greater than the minimum support value, put it in the large 1-itemsets ( $L_1^k$ ) at level  $k$ . That is,

$$L_1^k = \{ \max - R_j^k \mid \max - \text{count}_j^k \geq \alpha, 1 \leq j \leq m^k \}.$$

STEP 9: If  $L_1^k$  is null, then set  $k = k + 1$  and go to STEP 4; otherwise, do the next step.

STEP 10: Generate the candidate set  $C_2^k$  from  $L_1^1, L_1^2, \dots, L_1^k$  to find "level-crossing" large itemsets. Each 2-itemset in  $C_2^k$  must contain at least one item in  $L_1^k$  and the other item may not be its ancestor in the taxonomy. All possible 2-itemsets are collected in  $C_2^k$ .

STEP 11: For each newly formed candidate 2-itemset  $s$  with items  $(s_1, s_2)$  in  $C_2^k$ :

- Calculate the fuzzy value of  $s$  in each transaction datum  $D_i$  as  $f_{is} = f_{is_1} \wedge f_{is_2}$ , where  $f_{is_j}$  is the membership value of  $D_i$  in region  $s_j$ . If the minimum operator is used for the intersection, then  $f_{is} = \min(f_{is_1}, f_{is_2})$ .
- Calculate the scalar cardinality of  $s$  in the transaction data as:

$$\text{count}_s = \sum_{i=1}^n f_{is}.$$

- If  $\text{count}_s$  is larger than or equal to the

predefined minimum support value  $\alpha$ , put  $s$  in  $L_2^k$ .

STEP 12: Set  $r=2$ , where  $r$  is used to represent the number of items stored in the current large itemsets.

STEP 13: If  $L_r^k$  or  $C_{r+1}^k$  is null, then set  $k=k+1$  and go to STEP 3; otherwise, do the next step.

STEP 14: Generate the candidate set  $C_{r+1}^k$  from  $L_r^k$  in a way similar to that in the apriori algorithm. That is, the algorithm first joins  $L_r^k$  and  $L_r^k$ , assuming that  $r-1$  items in the two itemsets are the same and the other one is different. The different items must also not have a hierarchical relationship. That is, items may not be ancestors or descendants of one another. Store in  $C_{r+1}^k$  all itemsets having all their sub-  $r$ - itemsets in  $L_r^k$ .

STEP 15: For each newly formed  $(r+1)$ -itemset  $s$  with items  $(s_1, s_2, \dots, s_{r+1})$  in  $C_{r+1}^k$ :

- Calculate the fuzzy value of  $s$  in each transaction datum  $D_i$  as

$$f_{is} = f_{is_1} \wedge f_{is_2} \wedge \dots \wedge f_{is_r},$$

where  $f_{is_j}$  is the membership value of  $D_i$  in region  $s_j$ . If the minimum operator is used for the intersection, then:

$$f_{is} = \text{Min}_{j=1}^r f_{is_j}.$$

- Calculate the scalar cardinality of  $s$  in the transaction data as:

$$\text{count}_s = \sum_{i=1}^n f_{is}.$$

- If  $\text{count}_s$  is larger than or equal to the predefined minimum support value  $\alpha$ , put  $s$  in  $L_{r+1}^k$ .

STEP 16: If  $L_{r+1}^k$  is null and  $k$  reaches the level number of the fuzzy taxonomic structures, then do the next step to find association rules; otherwise, set  $r=r+1$  and go to STEP 13.

STEP 17: Construct the fuzzy association rules for all large  $q$ -itemset  $s$  containing items  $(s_1, s_2, \dots, s_q)$ ,  $q \geq 2$ , as follows.

- Form all possible association rules as:

$$s_1 \wedge \dots \wedge s_k \wedge s_{k+1} \wedge \dots \wedge s_q \rightarrow s_k,$$

$k=1$  to  $q$ .

- Calculate the confidence values of all association rules using the formula:

$$\frac{\sum_{i=1}^n f_{is}}{\sum_{i=1}^n (f_{is_1} \wedge \dots \wedge f_{is_{k-1}}, f_{is_{k+1}} \wedge \dots \wedge f_{is_q})}$$

STEP 18: Keep the rules with confidence values larger than or equal to the predefined confidence threshold  $\lambda$ . Output the rules with their support measures and confidence measures larger than or equal to the predefined  $\lambda$  and  $\alpha$  threshold to users as generalized association rules.

The rules output from Steps 18 can then serve as meta-knowledge concerning the given transactions.

## 6. An Example

In this section, an example is given to illustrate the proposed data-mining algorithm. This is a simple example to show how the proposed algorithm generates association rules from quantitative transactions using fuzzy taxonomic structures. The data set includes the six transactions shown in Table 2.

Table 2. Six transactions in this example

Transaction ID	Items
1	(Apple, 3) (Tomato, 4) (Beef, 2)
2	(Tomato, 7) (Cabbage, 7) (Beef, 7)
3	(Tomato, 2) (Cabbage, 10) (Beef, 5)
4	(Cabbage, 9) (Beef, 10)
5	(Apple, 7) (Pork, 9)
6	(Apple, 2) (Tomato, 8)

Each transaction includes a transaction ID and some purchased items. Each item is represented by a tuple (item name, item amount). For example, the fourth transaction consists of nine units of cabbage and ten units of beef. Assume the predefined fuzzy taxonomic structures are as shown in Figure 2. For convenience, the simple symbols in Table 3 are used to represent the items and groups.

Table 3. Items and groups are represented by simple symbols for convenience

Items	Symbol	Groups	Symbol
Apple	A	Fruit	T <sub>1</sub>
Tomato	B	Vegetable	T <sub>2</sub>
Cabbage	C	Vegetable dishes	T <sub>3</sub>
Pork	D	Meat	T <sub>4</sub>
Beef	E		

Also assume that the fuzzy membership functions are the same for all the items and are as shown in Figure 3.

In this example, amounts are represented by three fuzzy regions: Low, Middle and High. Thus, three fuzzy

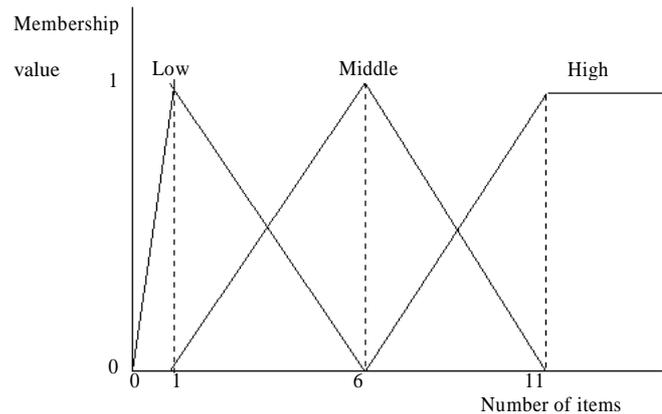


Figure 3. The membership functions used in this example

membership values are produced for each item amount according to the predefined membership functions. Assume in this example, the support threshold  $\alpha$  is set at 1.5 and the confidence threshold  $\lambda$  is set at 0.7. For the transaction data in Table 2, the following three rules are mined from the proposed algorithm:

1. If E = Middle, then T<sub>3</sub> = High, with a support value of 1.8 and a confidence value of 0.9;
2. If E = Middle, then T<sub>3</sub> = High, with a support value of 1.92 and a confidence value of 0.96;
3. If T<sub>4</sub> = Middle, then T<sub>3</sub> = High, with a support value of 2.12 and a confidence value of 0.82.

These three rules can then serve as meta-knowledge concerning the given transactions.

## 7. Discussion and Conclusions

In this paper, we have proposed a fuzzy multiple-level data-mining algorithm that can process transaction data with quantitative values among them. The rules thus mined exhibit quantitative regularity on multiple levels and can be used to provide suggestions to appropriate supervisors.

Although the proposed method works well in data mining for quantitative values, it is just a beginning. There is still much work to be done in this field. Our method also assumes that membership functions are known in advance. In [15-17], we proposed some fuzzy learning methods to automatically derive membership functions. We will therefore attempt to dynamically adjust the membership functions in the proposed mining algorithm to avoid the bottleneck of membership function acquisition. We will also attempt to design specific data-mining models for various problem domains.

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## References

- [1] R. Agrawal, T. Imielinski and A. Swami, "Mining association rules between sets of items in large database," The 1993 ACM SIGMOD Conference on Management of Data, Washington DC, USA, 1993, pp. 207-216.
- [2] R. Agrawal, T. Imielinski and A. Swami, "Database mining: a performance perspective," IEEE Transactions on Knowledge and Data Engineering, Vol. 5, No. 6, 1993, pp. 914-925.
- [3] A. F. Blishun, "Fuzzy learning models in expert systems," Fuzzy Sets and Systems, Vol. 22, 1987, pp. 57-70.
- [4] L. M. de Campos and S. Moral, "Learning rules for a fuzzy inference model," Fuzzy Sets and Systems, Vol. 59, 1993, pp. 247-257.
- [5] R. L. P. Chang and T. Pavliddis, "Fuzzy decision tree algorithms," IEEE Transactions on Systems, Man and Cybernetics, Vol. 7, 1977, pp. 28-35.
- [6] M. S. Chen, J. Han and P. S. Yu, "Data mining: an overview from a database perspective," IEEE Transactions on Knowledge and Data Engineering, Vol. 8, No. 6, 1996, pp. 866-883.
- [7] C. Clair, C. Liu and N. Pissinou, "Attribute weighting: a method of applying domain knowledge in the decision tree process," The Seventh International Conference on Information and Knowledge Management, 1998, pp. 259-266.
- [8] M. Delgado and A. Gonzalez, "An inductive learning procedure to identify fuzzy systems," Fuzzy Sets and Systems, Vol. 55, 1993, pp. 121-132.
- [9] A. Famili, W. M. Shen, R. Weber and E. Simoudis, "Data preprocessing and intelligent data analysis," Intelligent Data Analysis, Vol. 1, No. 1, 1997, pp. 3-23.
- [10] W. J. Frawley, G. Piatetsky-Shapiro and C. J. Matheus, "Knowledge discovery in databases: an overview," The AAAI Workshop on Knowledge Discovery in Databases, 1991, pp. 1-27.
- [11] T. Fukuda, Y. Morimoto, S. Morishita and T. Tokuyama, "Mining optimized association rules for numeric attributes," The ACM SIGACT-SIGMOD-SIGART Symposium on Principles of Database Systems, June 1996, pp. 182-191.
- [12] A. Gonzalez, "A learning methodology in uncertain and imprecise environments," International Journal of Intelligent Systems, Vol. 10, 1995, pp. 57-371.
- [13] J. Han and Y. Fu, "Discovery of multiple-level association rules from large databases," The International Conference on Very Large Databases, 1995, pp. 420-431.
- [14] T. P. Hong, C. S. Kuo and S. C. Chi, "A data mining algorithm for transaction data with quantitative values," Intelligent Data Analysis, Vol. 3, No. 5, 1999, pp. 363-376.
- [15] T. P. Hong and J. B. Chen, "Finding relevant attributes and membership functions," Fuzzy Sets and Systems, Vol. 103, No. 3, 1999, pp. 389-404.
- [16] T. P. Hong and J. B. Chen, "Processing individual fuzzy attributes for fuzzy rule induction," Fuzzy Sets and Systems, Vol. 112, No. 1, 2000, pp. 127-140.
- [17] T. P. Hong and C. Y. Lee, "Induction of fuzzy rules and membership functions from training examples," Fuzzy Sets and Systems, Vol. 84, 1996, pp. 33-47.
- [18] T. P. Hong and K. Y. Lin, "Fuzzy data mining using taxonomy," The 2000 Eighth National Conference on Fuzzy Theory and Its Applications, 2000.
- [19] A. Kandel, Fuzzy Expert Systems, CRC Press, Boca Raton, 1992, pp. 8-19.
- [20] R. S. Michalski, I. Bratko and M. Kubat, Machine Learning and Data Mining: Methods and Applications, John Wiley & Sons Ltd, England, 1998.
- [21] J. R. Quinlan, "Decision tree as probabilistic classifier," The Fourth International Machine Learning Workshop, Morgan Kaufmann, San Mateo, CA, 1987, pp. 31-37.
- [22] J. R. Quinlan, C4.5: Programs for Machine Learning, Morgan Kaufmann, San Mateo, CA, 1993.
- [23] R. Rastogi and K. Shim, "Mining optimized association rules with categorical and numeric attributes," The 14th IEEE International Conference on Data Engineering, Orlando, 1998, pp. 503-512.
- [24] R. Rastogi and K. Shim, "Mining optimized support rules for numeric attributes," The 15th IEEE International Conference on Data Engineering, Sydney, Australia, 1999, pp. 206-215.
- [25] J. Rives, "FID3: fuzzy induction decision tree," The First International Symposium on Uncertainty, Modeling and Analysis, 1990, pp. 457-462.
- [26] R. Srikant and R. Agrawal, "Mining Generalized Association Rules," The International Conference on Very Large Databases, 1995.
- [27] R. Srikant and R. Agrawal, "Mining quantitative association rules in large relational tables," The 1996 ACM SIGMOD International Conference on Management of Data, Monreal, Canada, June 1996, pp. 1-12.
- [28] R. Srikant, Q. Vu and R. Agrawal, "Mining association rules with item constraints," The Third International Conference on Knowledge Discovery in Databases and Data Mining, Newport Beach, California, August 1997, pp. 67-73.
- [29] C. H. Wang, T. P. Hong and S. S. Tseng, "Inductive learning from fuzzy examples," The Fifth IEEE International Conference on Fuzzy Systems, New Orleans, 1996, pp. 13-18.
- [30] C. H. Wang, J. F. Liu, T. P. Hong and S. S. Tseng, "A fuzzy inductive learning strategy for modular rules," Fuzzy Sets and Systems, Vol. 103, No. 1, 1999, pp. 91-105.
- [31] R. Weber, "Fuzzy-ID3: a class of methods for automatic knowledge acquisition," The Second International Conference on Fuzzy Logic and Neural Networks, Iizuka, Japan, 1992, pp. 265-268.
- [32] Qiang Wei and Guoqing Chen, "Mining Generalized Association Rules with Fuzzy Taxonomic Structures," The 18th International Conference of the North American Fuzzy Information Processing Society, NAFIPS, 1999, pp. 477-481.
- [33] Y. Yuan and M. J. Shaw, "Induction of fuzzy decision trees," Fuzzy Sets and Systems, 69, 1995, pp. 125-139.
- [34] L. A. Zadeh, "Fuzzy sets," Information and Control, Vol. 8, No. 3, 1965, pp. 338-353.

# OMARS: The Framework of an Online Multi-Dimensional Association Rules Mining System

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## Abstract

Recently, the integration of data warehouses and data mining has been recognized as the primary platform for facilitating knowledge discovery. Effective data mining from data warehouses, however, needs exploratory data analysis. The users often need to investigate the warehousing data from various perspectives and analyze them at different levels of abstraction. To this end, comprehensive information processing and data analysis have to be systematically constructed surrounding data warehouses, and an on-line mining environment should be provided. In this paper, we propose a system framework to facilitate on-line association rules mining, called OMARS, which is based on the idea of integrating OLAP service and our proposed OLAM cubes and auxiliary cubes. According to the concept of OLAM cubes, we define the OLAM lattice framework that exploit arbitrary hierarchies of dimensions to model all possible OLAM data cubes.

## 1. Introduction

Over the past few years, data warehouse has been recognized and widely adopted as a platform for storing integrated, detailed, summarized, and historical data. Nowadays, most data warehousing systems are designed to accomplish On-Line Analytical Processing (OLAP), the process of creating and managing multidimensional data for analysis. But with the rapid growth of various requisitions, the OLAP-like tools that provide aggregation charts or tables to visualize data cannot supply further exploration of requisition from different levels of business management. This heralds the development of data mining techniques to discover implicit knowledge from a huge collection of data. One of the predominant techniques in data mining community is association rule mining, which refers to the discovery of associations from a list of database transactions. An example association rule is that "80% of customers who buy product 'A' also buy product 'B'". Such rules reveal customers' buying behavior and can be used in various decision strategies, such as catalog design, cross-sale, customer classification and product layout.

In real world applications, data are featured in multidimensional attributes. The decision makers usually want to analyze the data from various aspects to inspire new insight to achieve competitive advantage. To date,

though many researchers have proposed various methods to discover associations from data warehouses [1][2][3][4][6][10][11][12], many problems remain unsolved. Some of them are

- 1) Nowadays, most data warehouses adopt the star schema to organize the stored data, which allows the users to explore the data from diverse aspects. Current association mining methods, however, fail to exploit all possible patterns hidden in the star schema. This would restrain an expert from discovering new insight.
- 2) It is well-known that the techniques of data preprocessing and view materialization widely used in query processing and OLAP analysis also could favor on-line re-mining task. For example, the work in [3][4][12] suggested using the OLAP data cube to employ on-line data mining such as association, sequential patterns, classification, etc. However, an inappropriate cube definition cannot fit the on-line mining environment. First, the OLAP-like aggregated cube cannot exploit all of the item relationships such as intra-dimensional or hybrid associations. Mining associations from OLAP cubes still requires a lot of computations. Second, the OLAP cube based paradigm is unfeasible when users want to change the constraints such as support threshold and employ a sequence of re-mining tasks. Each re-mining requires executing the whole procedure to generate frequent itemsets.

To this end, we propose a system framework for on-line association rules mining, called OMARS (Online Multidimensional Association Rules mining System), which adopts the idea of pre-computing and materializing cube like OLAP, and integrates the OLAP cubes and our proposed OLAM cubes and auxiliary cubes to realize on-line association mining environment.

The remaining of this paper is organized as follows. In Section 2, we introduce some background material. The previous work related to our research is described in Section 3. Section 4 explains our OMARS framework and details each constituent. Finally, we conclude with suggestions and future work in Section 5.

## 2. Background

### 2.1 Data Warehouse and Data Model

The term ‘data warehouse’ was first coined by W. H. Inmom as a “subject-oriented, integrated, time-variant and nonvolatile collection of data in support of management’s decision-making process” [7]. Although the data stored in data warehouses have been cleaned, filtered, and integrated, it still takes much time to translate the data into the strategic information because of massive amounts of data. To improve the performance, most data warehouses adopt some preprocessing tools like OLAP service. The term ‘OLAP’ is the acronym of ‘On-Line Analytical Preprocessing’, which refers to the process of creating and managing multidimensional data for analysis and visualization. Typical OLAP operations include roll-up (increasing the level of abstraction), drill-down (decreasing the level of abstraction), slice and dice (selection and projection) and pivot (re-orienting the multidimensional view of data) [5].

In the world of decisions making, managers tend to view the analyzed data from different business perspectives. As a primary repository for decision support, the data warehouse has to model the data multi-dimensionally. The most popular dimensional modeling of data warehouse is star schema [8]. A star schema consists of a central table, called fact table, and several dimension tables. The fact table consists of numeric measures and some foreign keys. Each dimension table contains a set of attributes that represent the user’s business perspectives and are often organized in the form of a hierarchical relationship. Figure 1 shows an example star schema for sales data.

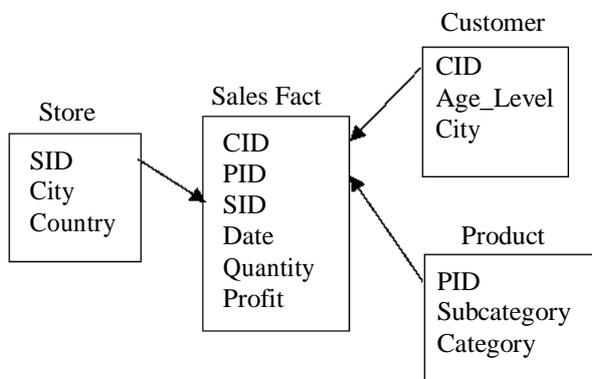


Figure 1. An example star schema for sales data.

## 2.2 Association Rules Mining

One of the predominant techniques used in data mining is association rule. An association rule,  $A \rightarrow B$ , denotes the relations between itemsets A and B, which means itemset B tends to appear together with itemset A. For this rule being interesting, the support of A and B, i.e., the number of transactions containing both A and B, denoted as  $\text{sup}(A \cup B)$ , should be more than a user-specified minimum support, called minsup ( $\text{sup}(A \cup B) \geq \text{minsup}$ ), and the confidence, measured as the conditional probability  $P(B|A)$ , should also be more than a user-specified minimum confidence, called minconf ( $P(B|A) \geq \text{minconf}$ ).

In general, the work for mining association rules can be decomposed into two phases:

- 1) Frequent itemsets generation: find all itemsets whose supports sufficiently exceed the minsup.
- 2) Rules construction: from the discovered frequent itemsets, generate the association rules. More precisely, for each frequent itemset X, construct the rule  $(X-Y) \rightarrow Y$ , if  $P(Y|X-Y) \geq \text{minconf}$ , where Y is a proper subset of X.

## 2.3 Multi-Dimensional Association Rules

The association mining is originally motivated by discovering frequently purchased patterns from a list of supermarket transactions. Traditionally, only one attribute, e.g., Product, is concerned in the association mining.

In real life, data often involves several tables and a table usually contains multiple attributes. For example, a data warehouse fact table may involves multiple dimension tables with multiple hierarchies. When mining from this kind of multidimensional data sets, users may want to observe the inter relations among the values of dimensions, i.e., a multi-dimensional view of the associations. We call such kind of association rules the multidimensional association rules. In [12], Han, Chee, and Chiang defined three different types of association rules involved multidimensional attributes.

- 1) Inter-dimensional association rule: This kind of rules reveals the associations between a set of dimensions.
- 2) Intra-dimensional association rule: This kind of rules exploits the associations between different items within only one dimension.
- 3) Hybrid association rule: This kind of rules also exploits the associations between a set of dimensions, but allows some items in a rule are from one dimension. It can be regarded as a combination of inter-dimensional and intra-dimensional rules.

According to the above description, intra-dimensional association rules, indeed, correspond to single-dimensional association rules, which can be defined as follows:

Definition 1. Consider a transaction table composed of k dimensions  $\{d_1, d_2, \dots, d_k\}$ . An intra-dimensional association rule can be expressed as

$$(d_i, "x_1"), (d_i, "x_2"), \dots, (d_i, "x_m") \rightarrow (d_i, "y_1"), (d_i, "y_2"), \dots, (d_i, "y_n"),$$

where  $x_j$  and  $y_j$  represent the values of dimension  $d_i$  and  $1 \leq i \leq k, 1 \leq m \leq j, 1 \leq n \leq j$ .

For example, an intra-dimensional association rule

$$(\text{Product}, \text{"diet coke"}) \rightarrow (\text{Product}, \text{"pretzels"})$$

says that most of customers who buy product “diet coke” also buy “pretzels” at the same transaction time. We thus say this kind of rules reveals the intra-relation among

products in the same dimension “Product”.

Following the concept in [12], we can define the multi-dimensional association rules, inter-dimensional or hybrid, as follows:

Definition 2. Consider a transaction table composed of  $k$  dimensions. Let  $x_{im}$  and  $y_{jn}$  be the values of dimensions  $X_i$  and  $Y_j$ , respectively. The form of a multi-dimensional association rule is:

$$(X_1, "x_{1m}"), (X_2, "x_{2m}"), \dots, (X_i, "x_{im}") \rightarrow (Y_1, "y_{1n}"), (Y_2, "y_{2n}"), \dots, (Y_j, "y_{jn}")$$

For example, an inter-dimensional rule

$$(City, "Taipei"), (Gender, "Female") \rightarrow (Product, "pretzels")$$

says that female customers living in “Taipei” tend to buy “pretzels”. And a hybrid association rule

$$(City, "Taipei"), (Gender, "Female"), (Product, "juice") \rightarrow (Product, "pretzels")$$

says that female customers living in “Taipei” that buy “juice” tend to buy “pretzels”.

### 3. Related Work

Without any pre-computation, the authors in [2] proposed an algorithm, called Carma, to realize on-line computation of frequent itemsets using only two database scans. In the course of the first database scan, the algorithm continuously constructs a lattice of potential frequent itemsets, displays the result, and allows users to adjust the threshold at any time. At the second scan, it determines the precise support of each set of lattice and then removes all infrequent itemsets. We observed that

- 1) The performance of Carma is better than Apriori or DIC when the support threshold is much small. However, it cannot defeat Apriori or DIC when the support threshold is larger than a critical value.
- 2) The performance of Carma is worse than on-line mining with preprocessing technique, because the whole mining procedure is carried out repeatedly. If the data is so large that it cannot be handled in real-time, the performance may be much worse.
- 3) It ignores the fact that in real world most data have diverse characteristics. The users may want to explore the associations from multi-dimensional viewpoints.

Aggarwal and Yu [1] considered the on-line rules generation and provided a lattice-based approach, called adjacency lattice, to pre-fine and pre-store the primary itemsets. They analyzed the on-line queries and proposed several adjacency lattice based algorithms. Users working with their on-line mining framework are free to launch different queries at different thresholds. Their approach, however, may suffer the following problems:

- 1) If the adjacency lattice is complex and large, the preprocessing time for constructing the lattice will become unacceptable.

- 2) It is difficult to trade off the amount of pre-stored data against the query time.

Recently, a promising direction for realizing on-line data mining has been proposed. The basic idea is to combine OLAP and data mining, called OLAP Mining [3][4][6][12]. However, we observe the following problems about this approach.

- 1) In most cases, inter association rules and hybrid association rules appear simultaneously in multi-dimensional OLAP mining. For example, if we group ‘Customer’ into transactions and choose ‘Product’ and ‘Store’ as mining attributes, the rules may be:

$$\text{Store("Mexico")} \rightarrow \text{Product("Berry")}$$

or

$$\text{Store("Mexico"), Product("tents")} \rightarrow \text{Product("Berry").}$$

Thus, it is hard to differentiate hybrid association rule from inter association rule in multi-dimensional association mining.

- 2) Because of lacking support for on-line re-mining, one has to invoke the whole mining procedure, and so cannot discover the frequent itemsets in real-time when the data cube is very large.

In [11] the authors proposed the concept of using materialized itemsets for fast mining of association rules. The approach divides the database into a set of non-overlapping partitions according to some attributes, e.g., education type of customers, store location, product category, and generates the frequent itemsets in each partition according to the local threshold. Then, the positive borders corresponding to the frequent itemsets in each partition are computed. Finally, all positive borders are combined to re-mine the new frequent itemsets with supports greater than the global threshold.

The FARM framework presented in [10] addressed the problem of mining associations from multi-attribute databases. Their framework particularly concentrates on exploring the mining spaces without specifying what attributes are used to group records into transactions and what attributes are used to define items. The method for counting support, however, is different from the existential aggregating functions. They also proposed three different types of downward closures and used them to implement an efficient Apriori-like mining algorithm. The FARM framework, however, ignores the following issues:

- 1) Lacking interaction: Users cannot perform the queries with different thresholds.
- 2) Costly for virtuous refinement: Like OLAP mining, FARM needs to discover the frequent itemsets by repeating the whole mining process whenever the threshold is increased or decreased.

### 4. The OMARS Framework

In this section, we describe the proposed framework for integrating data warehouse, OLAP processing and our OLAM cubes and auxiliary cubes to build an on-line multidimensional association mining environment.

Through this system, the users can interactively change their viewpoints, refine the constraints according to the observed result, and perform further exploration.

#### 4.1 Panorama

Figure 2 depicts the OMARS framework, which is deployed to meet the following characteristics of on-line multidimensional association mining.

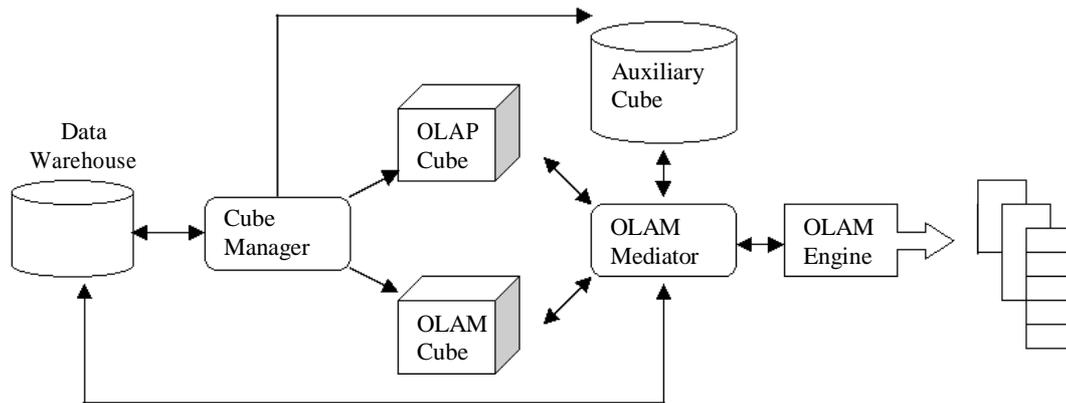


Figure 2. The OMARS framework.

To this end, we propose the concept of OLAM data cube, which stores the frequent itemsets with respect to various groupings of dimension attributes. We also make use of the OLAP service supported by most data warehousing systems, and integrate the OLAP cube and our OLAM cube to meet simultaneously these two different analyses. Our intention is to develop an add-on service instead of a stand-alone system to commercial data warehousing products. The task of on-line association mining is employed through the following two phases:

- 1) Off-line preprocessing phase: This phase concerns the construction of the data cubes. The data in data warehouses are preprocessed and stored in different repositories, including OLAP Cube, OLAM Cube and Auxiliary Cube. The Cube Manager component is in charge of the cube construction and maintenance, either regularly or irregularly.
- 2) On-line mining phase: Once the itemsets with supports above a presetting threshold, prims, in the preprocessing phase are materialized, the OLAM Engine forwards the user query to the OLAM Mediator, which then searches for the most appropriate cube to answer the association query. However, if the threshold of the query is lower than the presetting threshold specified in the preprocessing phase, the OLAM Engine will make use of the auxiliary cubes and re-scan the database to answer the query.

The critical design issues for these two phases are:

- 1) Off-line preprocessing phase: how to define the presetting minimum support, and how to construct the OLAM cube and the auxiliary cubes that store

- 1) Users can perform OLAP-like explorations. That is, users can interactively change the dimensions that comprise the associations.
- 2) Users can refine the constraints such as minimum support and minimum confidences, and see the response in no time.

the frequent itemsets with supports greater than prims and the infrequent itemsets with supports less than prims, respectively.

- 2) On-line mining phase: how to re-use the existential information stored in OLAM, OLAP and auxiliary cubes to facilitate the on-line association mining from various perspectives.

The first phase involves Data Warehouse, Cube Manager, OLAP Cube, OLAM Cube and Auxiliary Cube, while the second phase involves OLAM Engine, OLAM Mediator, OLAP Cube, OLAM Cube and Auxiliary Cube. In the following sections, we will elaborate each constituent of the framework.

#### 4.2 Cube Manager

As stated previously, Cube Manager is responsible for cube generation and maintenance. More precisely, the work of Cube Manager consists of three different parts.

- 1) Cube selection: This part concerns the problem of how to select the most appropriate set of data cubes for materialization in order to minimize the query cost and/or maintenance cost under the constraint of limited storage.
- 2) Cube computation: This part deals with the work for efficiently generating the set of materialized cubes selected by the cube selection module.
- 3) Cube maintenance: This deals with the task of how to maintain the materialized cubes when there are updates to the data warehouse.

### 4.3 OLAM Mediator and OLAM Engine

The primary task of OLAM Engine is to generate the association rules. It accepts various queries from users and invokes the most appropriate algorithm according to the dimensional attributes and the minsup of the query. After receiving a query, the OLAM Engine first analyzes the query and forwards the necessary information to OLAM Mediator, and then waits for the most relevant cube from OLAM Mediator to generate the qualified association rules.

On the other hand, when OLAM Mediator receives the messages about the user query from OLAM Engine, it will look for the most matching cube. First, OLAM Mediator

judges whether the input minsup is greater than primsup or not. If the input minsup is smaller than primsup, it has to coordinate and communicate with Auxiliary Cube and data warehouse, and return the matching jointed table to OLAM Engine. Otherwise, it will check that whether the required cube exists in OLAM Cube or not. If not, it will search for OLAP Cube and return the matching cube to OLAM Engine. In the worst case, when in OLAM Cube and OLAP Cube no cube matches the query, it will re-scan the data warehouse and notify OLAM Engine to execute the whole mining procedure afresh.

Figure 3 depicts the cooperation between OLAM Mediator and OLAM Engine.

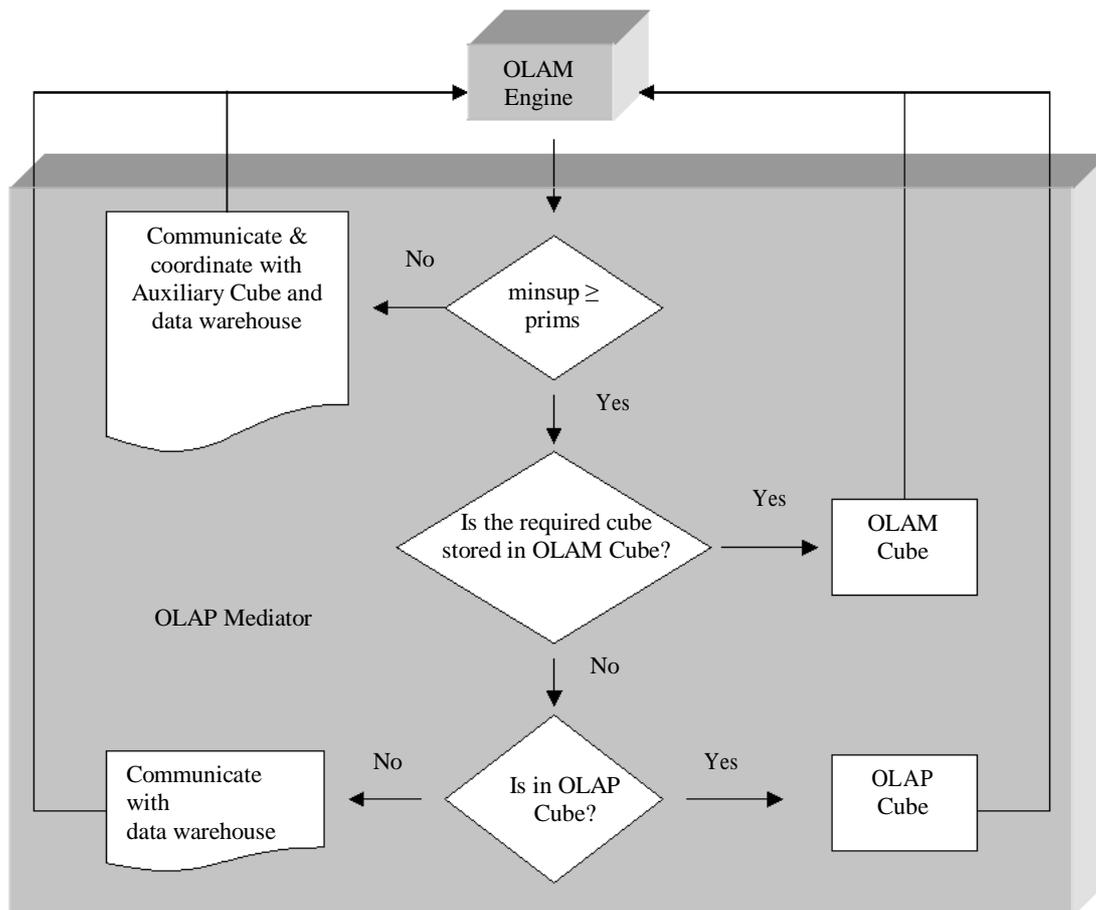


Figure 3. Flow diagram of OLAM Mediator and OLAM Engine.

### 4.4 OLAM Cube and OLAM Lattice

The concept of OLAM data cube is used to store the frequent itemsets with supports greater than the pre-setting support threshold primsup, in the off-line preprocessing phase. The intuition is to accelerate the process of association mining by utilizing these materialized frequent itemsets. To clarify the structure of OLAM cubes, we first specify the form of multidimensional association query, which is defined as a four-tuple mining meta-pattern.

Definition 3. Consider a star schema  $S$  containing a fact table and  $m$  dimension tables  $\{D_1, D_2, \dots, D_m\}$ . Let  $T$  be a jointed table from  $S$  composed of  $a_1, a_2, \dots, a_r$  attributes, such that  $\forall a_i, a_j \in A(D_k)$  there is no hierarchical relation between  $a_i$  and  $a_j$ , and  $1 \leq i, j \leq r, 1 \leq k \leq m$ . A meta-pattern of multidimensional associations from  $T$  is defined as follows:

$$MP: \langle t_G, t_M, ms, mc \rangle,$$

where  $ms$  denotes the minimum support,  $mc$  the minimum confidence,  $t_G$  the group of transaction attributes,  $t_M$  the

group of mining attributes,  $t_M \subseteq \{a_1, a_2, \dots, a_r\}$  and  $t_G \cap t_M = \emptyset$ .

Note that this meta-form specification of multi-dimensional association queries can present three different multidimensional association rules defined in [12], intra-dimensional, inter-dimensional, and hybrid associations.

For example, consider a jointed table T involving three dimensions from the star schema in Figure 1. The content of T is shown in Table 1. If the mining attribute set  $t_M$  consists of only one attribute, then the discovered rules present the intra-association. For example, if  $t_G = \{Cid, Date\}$ ,  $t_M = \{Category\}$ , we may have

$$(Category, "B"), (Category, "D") \rightarrow (Category, "E")$$

Otherwise, if  $|t_M| \geq 2$ , then the resulting associations will be inter-association or hybrid association, e.g.,  $t_G = \{Cid, Date\}$ ,  $t_M = \{Category, Age\_level, C.City\}$ , we have

$$(Age\_level, "21-30"), (C.City, "Taipei") \rightarrow (Category, "B"),$$

which is an inter-association, and

$$(Age\_level, "31-40"), (C.City, "New York"), (Category, "C") \rightarrow (Category, "D"),$$

a hybrid association.

Table 1. A jointed table T from star schema.

Tid	Cid	Date	Category	Age_level	City
1	C1	2001/01/12	B, C, D, E	21-30	Taipei
2	C1	2001/01/23	A, B, C	21-30	Taipei
3	C2	2001/02/01	B, C, D	31-40	New York
4	C4	2001/03/16	A, D	below 20	Toronto
5	C3	2001/03/16	A, B, D	41-50	Seattle
6	C2	2001/08/09	C, D, E	31-40	New York
7	C4	2001/08/09	D	below 20	Toronto
8	C3	2001/09/25	B, C, E	41-50	Seattle
9	C1	2001/09/26	B, D, E	21-30	Taipei
10	C2	2001/10/12	B, C, D, E	31-40	New York

\* A: Magazines, B: Electrical, C: Hardware, D: Drinks, E: Paper Products

We now proceed to clarify the OLAM cube structure.

**Definition 4.** For a meta-pattern MP with transaction attributes  $t_t$  and mining attributes  $t_m$ , and a presetting minsup, prims, the correspondent OLAM cube,  $MCube(t_G, t_M)$ , is the set of the frequent itemsets with supports larger than prims.

**Example 1.** A hybrid OLAM cube: Let  $|t_M| = 3$ ,  $t_G = \{Cid, Date\}$ ,  $t_M = \{Category, Age\_level, City\}$ , and prims = 3. The resulting OLAM cube is shown in Table 2.

Note that in an OLAM cube, an attribute value is viewed as an item and a tuple containing k-items represents a frequent k-itemset. For example, the last tuple represents a frequent 4-itemset, where the "Category" dimension of

the tuple contains several values, such as "C" and "D". An association rule derived from the last tuple will be

$$(C.City, "New York"), (Age\_level, "31-40") \rightarrow (Category, "C"), (Category, "D")$$

This rule reveals that the customers whose age is between 31 and 40 and who live in New York tend to buy product category "C" and "D".

Table 2. An example hybrid OLAM cube expressed in table.

Age_level	City	Category	Support
-	-	A	3
-	-	B	7
-	-	C	6
-	-	D	8
-	-	E	5
21-30	-	-	3
31-40	-	-	3
-	Taipei	-	3
-	New York	-	3
21-30	-	B	3
31-40	-	C	3
31-40	-	D	3
-	Taipei	B	3
-	New York	C	3
-	New York	D	3
21-30	Taipei	-	3
31-40	New York	-	3
21-30	Taipei	B	3
31-40	New York	C	3
31-40	New York	D	3
31-40	New York	C, D	3

**Example 2.** An intra-dimensional OLAM cube: Let  $|t_M| = 1$ ,  $t_G = \{Cid, Date\}$ ,  $t_M = \{Category\}$ , and prims = 4. The resulting OLAM cube is shown in Table 3.

Table 3. An example intra-dimensional OLAM cube expressed in table.

category	Support
B	7
C	6
D	8
E	5
B, C	5
B, D	5
B, E	4
C, D	4
C, E	4

In this example, the attributes "Cid" and "Date" are grouped into transaction attributes and the "Category" is viewed as the mining attribute. There are 10 transactions in this table. Again, a tuple containing k-items represents a frequent k-itemset. From the last tuple that represents a

frequent 2-itemset, we can derive the following association rule:

$$(\text{Category}, \text{"C"}) \rightarrow (\text{Category}, \text{"E"}).$$

This rule says that those customers who buy category “C” tend to buy category “E”.

To allow the users mining associations from various perspectives, we have to exploit all possible OLAM cubes. Indeed, according to the definition of OLAM cube, all of the possible OLAM cubes generated from a given star schema can form an OLAM lattice. To provide a hierarchical navigation and multidimensional exploration, we model the OLAM lattice as a three-layer structure. The 1<sup>st</sup> layer lattice exploits all of the dimensional combinations.

The 2<sup>nd</sup> layer then further exploits the inter-attribute combinations for the selected dimensions in the 1<sup>st</sup> layer. Finally, the 3<sup>rd</sup> layer exploits all of the possible OLAM cubes corresponding to the meta-pattern that can be derived from the chosen subcubes in the 2<sup>nd</sup> layer. Note that the first two layers only serve the purpose for hierarchical navigation and dimensional exploration. The real OLAM cubes are stored in the 3<sup>rd</sup> layer.

For example, consider the star schema shown in Figure 1. We obtain eight possible dimensional combinations and construct the 1<sup>st</sup> layer lattice as shown in Figure 4. Each node in the 1<sup>st</sup> layer lattice represents a possible dimensional combination.

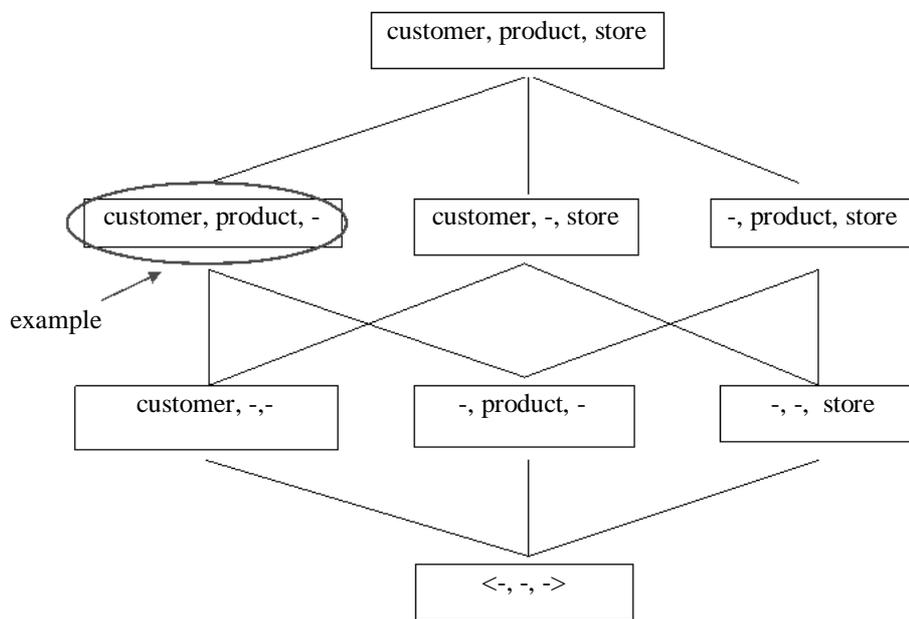


Figure 4. The 1<sup>st</sup> layer OLAM lattice for the example star schema in Figure 1.

Any node in the 1<sup>st</sup> layer lattice then can be extended to form a 2<sup>nd</sup> layer lattice. For example, consider the node composed of “customer” and “product” dimensions. Figure 5 shows the 2<sup>nd</sup> layer lattice derived from this node. Each node of the 2<sup>nd</sup> layer lattice is constructed by attaching any attribute chosen from the selected dimensions and the attributes are added one by one as traversing down the lattice. The traversing stops when all attributes of the selected dimensions appear in this bottom node.

Similarly, any node of the 2<sup>nd</sup> layer lattice can be further extended to form a 3<sup>rd</sup> layer lattice. Consider the <(City, Age\_level), (Category)> node in Figure 5. Figure 6 shows the 3<sup>rd</sup> lattice by extending <(City, Age\_level), (Category)>. There are eight different nodes in this lattice, where each

node represents an OLAM cube. As Figure 6 shows, the nodes can be divided into two different categories:

- 1) Intra-association cubes: These refer to at the 3<sup>rd</sup> level the nodes that contain only one mining attribute.
- 2) Inter- or hybrid association cubes: These include at the 1<sup>st</sup> level the nodes that contain no transaction attribute and at the 2<sup>nd</sup> level those that contain one transaction attribute.

Note that not all of the OLAM cubes derived in the lattice have to be materialized and stored. Indeed, the concept hierarchies defined over the attributes in the star schema provide the possibility to prune some redundant cubes.

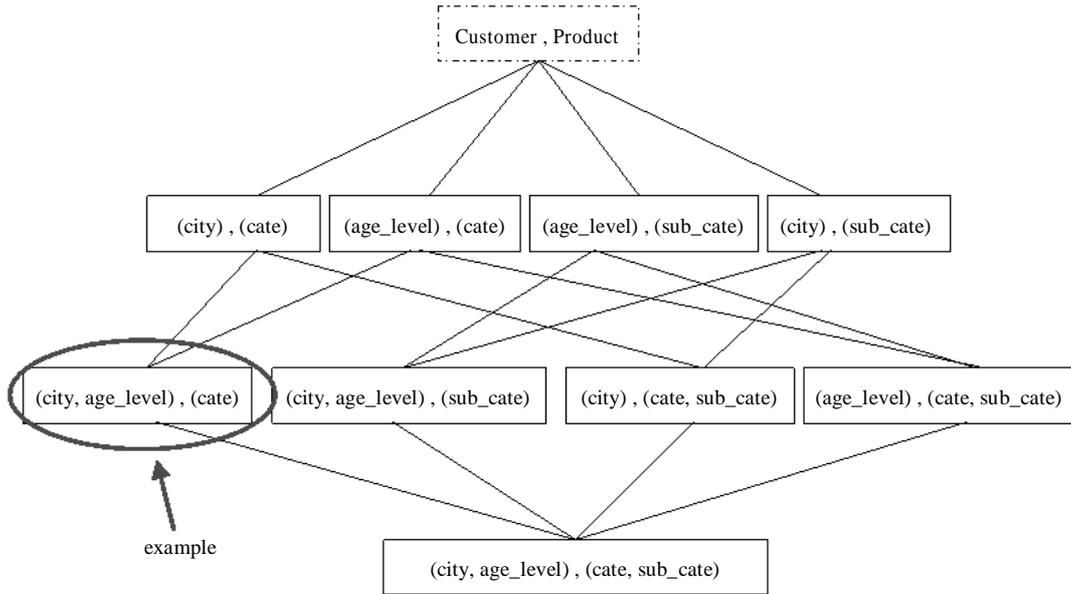


Figure 5. The 2<sup>nd</sup> layer lattice derived from <customer, product, -> in the 1<sup>st</sup> layer.

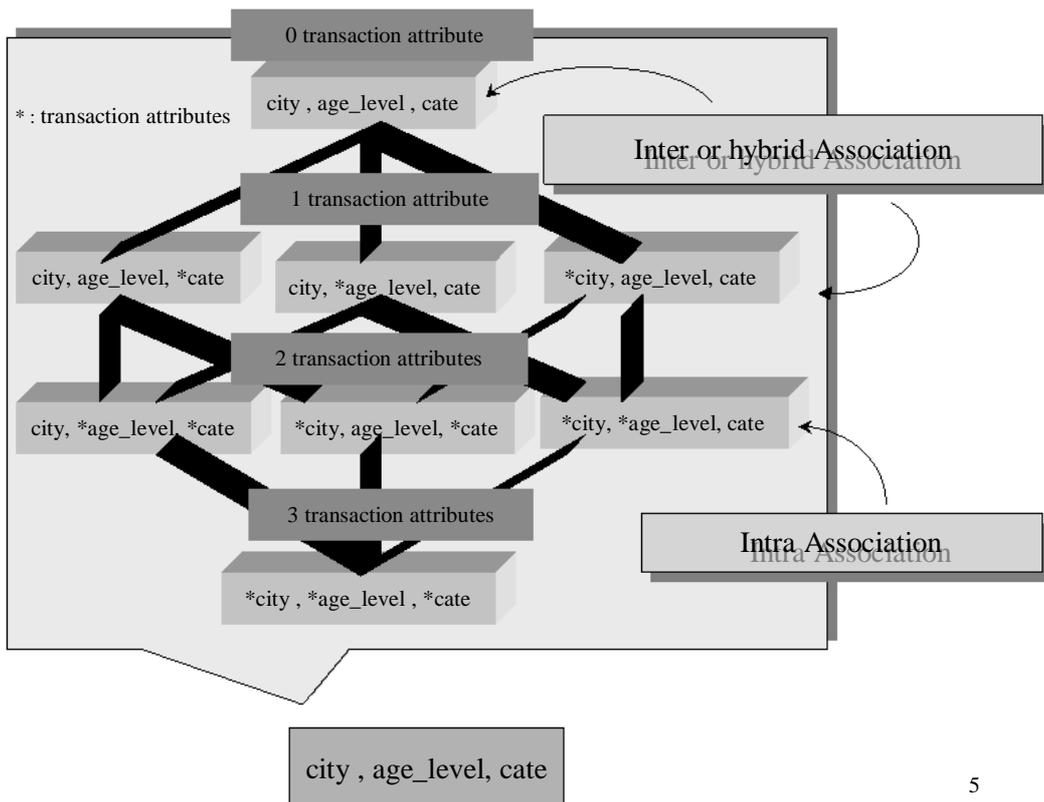


Figure 6. The 3<sup>rd</sup> layer lattice derived from the subcube <city, age\_level> in the 2<sup>nd</sup> layer.

Consider an OLAM cube,  $MCube(t_G, t_M)$ . We observed that there are two different types of redundancy.

Observation 1. Schema redundancy: Let  $a_i, a_j \in t_G$ . If  $a_i, a_j$  are in the same dimension and  $a_j$  is an ancestor of  $a_i$ , then  $MCube(t_G, t_M)$  is a redundancy of cube  $MCube(t_G - \{a_j\}, t_M)$ .

Example 3. Consider the jointed table in Table 4. Let  $|t_M| = 1$  and  $t_M = \{\text{Subcategory}\}$ . The resulting table by grouping “City” and “Country” as transaction attributes is shown in Table 5. Note that this table is the same as that by grouping “City” as the transaction attribute, as shown in Table 6. Thus, the resulting cube  $MCube(\{\text{City}, \text{Country}\},$

{Subcategory}) is the same as  $MCube(\{City\}, \{Subcategory\})$ .

Table 4. A jointed table from star schema.

Cid	City	Country	Category	Subcategory
C1	Tokyo	Japan	Personal Computer	Notebook
C1	Tokyo	Japan	Printer	Ink_Jet
C2	NY	USA	Personal Computer	Notebook
C2	NY	USA	Printer	Ink_Jet
C3	HK	China	Personal Computer	Desktop PC
C4	Toronto	Canada	Storage Hardware	Hard Disk
C5	Toronto	Canada	Storage Hardware	Hard Disk

Table 5. The resulting table by grouping {City, Country} as transaction attributes for Table 4.

City	Country	Subcategory
Tokyo	Japan	Notebook, Ink_Jet
New York	USA	Notebook, Ink_Jet
Hong Kong	China	Desktop PC
Toronto	Canada	Hard Disk

Table 6. The resulting table by grouping {City} as transaction attribute for Table 4.

City	Subcategory
Tokyo	Notebook, Ink_Jet
New York	Notebook, Ink_Jet
Hong Kong	Desktop PC
Toronto	Hard Disk

Table 7. The resulting OLAM cube  $MCube(\{Cid\}, \{Category, Subcategory\})$ .

Category	Subcategory	Support
PC	-	3
Printer	-	2
Storage Hardware	-	2
-	Notebook	2
-	Hard Disk	2
-	Ink_Jet	2
Printer	Notebook	2
Printer	Ink_Jet	2
PC	Ink_Jet	2
PC	Notebook	2
Storage Hardware	Hard Disk	2
-	Notebook, Ink_Jet	2
PC, Printer	-	2
PC, Printer	Ink_Jet	2
PC, Printer	Notebook	2
PC	Notebook, Ink_Jet	2
Printer	Notebook, Ink_Jet	2
PC, Printer	Notebook, Ink_Jet	2

Observation 2. Values Redundancy: Let  $a_i, a_j \in t_M$ . If  $a_i, a_j$  are in the same dimension and  $a_j$  is an ancestor of  $a_i$ , then  $MCube(t_G, t_M)$  is a cube with values redundancy.

Example 4. Consider the jointed table in Table 4. Let  $|t_M| = 2$ ,  $t_G = \{Cid\}$ ,  $t_M = \{Category, Subcategory\}$  and  $prims = 2$ . The resulting OLAM cube is shown in Table 7. We observe that the tuples with gray area in this table are redundant patterns. Therefore, it satisfies the values redundancy. Note that if it holds the values redundancy, we must prune the redundant patterns during the generation of frequent itemsets.

In addition, we observe that any OLAM cube is useless if it satisfies the following property.

Observation 3. Useless Property: Let  $a_i \in t_G$  and  $a_j \in t_M$ . If  $a_i, a_j$  are in the same dimension and  $a_j$  is an ancestor of  $a_i$ , then  $MCube(t_G, t_M)$  is a useless cube.

Example 5. Let  $|t_M| = 1$  and  $t_M = \{Category\}$ . The resulting table by grouping {Subcategory} as transactions is shown in Table 8. The cardinality of every transaction in this table is 1. Therefore, we cannot find any association rule from this table.

Table 8. The resulting table by grouping {Subcategory} as transaction attribute for Table 4.

Subcategory	Category
Notebook	Personal Computer
Ink_Jet	Printer
Desktop PC	Personal Computer
Hard Disk	Storage Hardware

#### 4.5 Auxiliary Cube

Though the OLAM cube is useful to generate associations for minsup larger than the pre-setting threshold, it becomes useless when the minsup is less than the threshold. In that case, we have to perform the mining task afresh, which probably will not satisfy the on-line demand.

To alleviate this problem, we propose the concept of auxiliary cube, which is used to store infrequent  $\alpha$ -itemsets generated in the off-line preprocessing phase, where  $\alpha$  denotes the cutting-level. For example, consider Table 1 and let  $\alpha = 3$  and  $prims = 4$ . Table 9 shows the auxiliary cube with respect to the intra-dimensional association, where "Cid" and "Date" are grouped as transaction attributes while "Category" is regarded as mining attribute. All tuples containing three items present infrequent 3-itemsets.

Though auxiliary cube can speed up on-line mining when  $minsup \leq prim$ , it consumes a lot of cube scanning time to locate the qualified itemsets when the auxiliary cube is very large. To prevent this problem, we partition the auxiliary cube into several sub-cubes to reduce the I/O cost. The structure of the partitioned auxiliary cube is shown in Figure 7. Assume  $prims = 0.5\%$ . We partition the auxiliary cube into three sub-cubes, with respect to three different ranges of thresholds, "0.5%-0.2%", "0.2%-0.1%" and "0.1%-0.0%". Next, we judge which sub-cube can answer the query. Because most of the infrequent itemsets appear

in “0.1%-0.0%” sub-cube, the I/O cost of scanning the other sub-cubes would be much low. For example, if the input threshold is between 0.5% and 0.2%, it just needs to scan the “0.5%-0.2%” sub-cube instead of scanning the whole auxiliary cube.

Table 9. An example of auxiliary cube for intra-dimensional association.

Itemset	Support
A, B, C	1
A, B, D	1
B, C, D	3
B, C, E	3
B, D, E	3
C, D, E	3

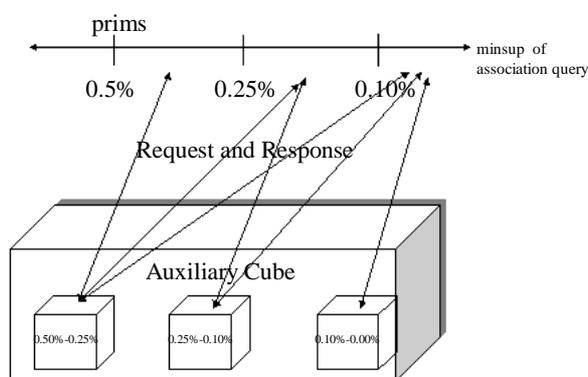


Figure 7. An example partition of auxiliary cube.

## 5. Conclusions

In this paper, we have proposed a system framework for on-line association rules mining, called OMARS. The goal of this framework is to provide an on-line mining environment to facilitate multidimensional exploration of association rules from data warehouses. To reach this goal, we adopted the concept of preprocessing, and proposed the concept of OLAM cubes and auxiliary cubes to store the frequent itemsets over a presetting minsup and the infrequent itemsets. We also proposed a three-layer OLAM lattice to organize all of the possible OLAM cubes in a systematic way. Through this three-layer lattice, users can carry out OLAP-like multidimensional exploration of association rules.

This paper present a preliminary result of our project on building a real on-line multidimensional association mining system. There remains much work, theoretical or

implemental, to accomplish to realize the proposed ORMAS on-line mining system.

## Acknowledgement

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## References

- [1] C.C. Aggarwal and P.S. Yu, “Online generation of association rules,” IEEE Transactions on Knowledge and Data Engineering, pp. 402-411, 1998.
- [2] C. Hidber, “Online association rule mining,” in Proceedings of the 1999 ACM SIGMOD International Conference on Management of Data, pp. 145-156, 1999.
- [3] J. Han, “OLAP Mining: An integration of OLAP with data mining,” in Proceedings of the 7th IFIP 2.6 Working Conference on Database Semantics (DS-7), pp. 1-9, 1997
- [4] J. Han, S. Chee, and J. Chiang, “Issues for on-line analytical mining of data warehouse,” in Proceedings of the 1998 ACM SIGMOD, Workshop on Research Issues on Data Mining and Knowledge Discovery, 1998.
- [5] J. Han and M. Kamber, Data Mining: Concepts and Techniques, Morgan Kaufmann Publishers, 2000.
- [6] J. Han, “Towards on-line analytical mining in large databases,” SIGMOD Record, Vol. 27, No. 1, 1998.
- [7] W.H. Inmon and C. Kelley (1993) Rdb/VMS: Developing the Data Warehouse, QED Publishing Group, Boston, Massachusetts.
- [8] R. Kimball, The Data Warehouse Toolkit Practical For Building Dimensional Data Warehouses, JOHN WILEY & SONS, 1996.
- [9] G. Psaila and P.L. Lanzi, “Hierarchy-based Mining of Association Rules in Data Warehouse,” in Proceedings of ACM’00, pp. 307-312, 2000.
- [10] C. Perng, H. Wang, S. Ma and J.L. Hellerstein, ” FARM: A framework for exploring mining spaces with multiple attributes,” in Proceedings of IEEE International Conference on Data Mining, pp. 449-456, 2001.
- [11] M. Wojciechowski and M. Zakrzewicz, “Itemset Materializing for Fast Mining of Association Rules,” in Proceedings of Second East European Symposium on Advances in Databases and Information Systems (ADBIS’98), Poznan, Poland, 1998, Lecture Notes in Computer Science 1475, Springer 1998.
- [12] H. Zhu, On-Line Analytical Mining of Association Rules, Master Thesis, Simon Fraser University, December 1998.

# Application of Text (Idea) Mining to Internet Surveys: Electronic Capture of the Structure of Ideas and Semantic Concepts

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## Abstract

This paper demonstrates a quick and efficient method of assessing the ideation structure for a group of people via the Internet and text mining. Data collection using the Internet is increasing; although the Internet has made access easier figuring out what people think is still a challenge. Email was used to contact and then direct survey respondents to a web site. At the web site, open-ended questions requiring text (type written) responses were asked. Conceptual (ideation) structure was obtained via an algorithm similar to that suggested by Quillian [7] and Bonnet [1]. To discover ideation structure, a modified Hopfield neural network based text-mining algorithm was used to obtain the statistical weights of ideas and concepts and the weights of the joint occurrences of the ideas and concepts with other ideas and concepts. Applying neural network technologies to text allows the analysis of open-ended responses without incurring the expensive, time-consuming and error-prone task of manually reading the open-ended comments. The Internet via email contact and web-based survey input dramatically speeds the process.

## 1. Introduction

Data are typically collected through surveys conducted by phone or through the mail, consumer interviews in malls, and focus groups. The increasing use of the Internet for data collection has made access easier; however, figuring out what people think is still a challenge. This paper demonstrates a quick and efficient method of assessing the ideation structure for a group of people.

This paper uses a combination of electronic methods to measure the ideation (concept) structure of university faculty interested in developing communities. Email was used to contact and the direct faculty to a web site. At the web site, open-ended questions requiring text (type written) responses were asked. Conceptual structure was obtained via algorithms similar to those suggested by Quillian [7], Bonnet [1] and Chung, Pottenger, and Schatz [3]. The goal of the application of methods was

to gather “collective wisdom” as quickly and efficiently as possible.

The content of the survey focused on thoughts, suggestions, and opinions regarding the startup and operation of a community development center at a major U.S. University. The survey focused on four textual questions; only one of these is reported in this paper: The faculty and staff’s suggestions on how to encourage community development activities on campus and local community. This study used E-mail and a Web site to conduct a survey, designed to capture via open-ended (text) responses, the structure of ideas and semantic concepts.

Faculty (and administrative and support staffs) were contacted by email and directed to a web survey site. The survey contained four open-ended (text) questions including current projects and activities related to community development, projects planned for the next year, interests in community housing projects, and suggestions regarding the promotion of community development activities. Specifically, this last question asked for suggestions about how to encourage/promote community development activities on the university campus.

## 2. Electronic Data Collection

Four weeks before the end of the spring term 2002, an email message was sent to all faculty and administrative staff introducing the respondents to the survey topic and then directing them to a web page, the survey’s URL. Two weeks later a reminder email was sent. One hundred and forty faculty and administrative staff responded to the survey request. The responding faculty and staff, of course, do not provide a representative sample of the entire faculty; however, they do represent those faculty and staff whom are highly interested in community development activities.

## 3. Discovery of Ideation Structure

Implementation of the analysis was accomplished via Text Analyst 2.0; the general idea of applying a modified Hopfield network to text is given in Chung, Pottenger, and Schatz [3].

The goal of the text analysis is to filter out meaningless elements, process the significant information, and identify the key semantic concepts contained within the text. Important concepts and word combinations from the text are identified by their frequencies of occurrence and joint occurrence with other concepts. The text is taken as a sequence of ideas organized by sentences into words. This sentence-string of words is moved through a window of variable length of text fragments. The goal is to discover ideation structure of the text. A modified Hopfield neural was used to obtain the statistical weights of ideas and concepts and the weights of the joint occurrences of the ideas and concepts with other ideas and concepts. The Hopfield network evolves by changing the weights assigned to the nodes and links between them into a stable configuration corresponding to the minimum of an energy function characterizing the semantic network. The ideation structure represents a conceptually accurate and concise map of the key ideas contained in the input text.

The modified Hopfield neural network is used to obtain a graph-like structure of statistical weights of concepts and the weights of the joint occurrences of these concepts with other concepts. The Hopfield network evolves by changing the weights assigned to the nodes and links between them into a stable configuration corresponding to the minimum of an energy function characterizing the semantic network. The semantic network represents a linguistically accurate and concise picture of the analyzed text. Applying neural network technologies to text allows the analysis of open-ended responses without incurring the expensive, time-consuming and error-prone task of manually reading the open-ended comments.

### 3.1 Modified Hopfield Algorithm

The Hopfield network is a neural network that may be viewed as a content-addressable memory structure. Knowledge and information is stored in single-layered interconnected neurons (or nodes) operating as memories representing patterns stored in the network. Algorithmic steps for the general application of a modified Hopfield algorithm to semantic networks are presented in Chung, Pottenger, and Schatz [3]. Their method is used below to illustrate the operations of Text Analysis 2.0.

#### 3.1.1 Preprocessing

Preprocessing is a language dependent activity. It involves removal of all ancillary and commonplace words, words that carry no semantic meaning. It also involves the identification of stems of the words, while separating prefixes and suffixes. Additional preprocessing includes pooling words with common stems, "mean" and "meaningful" for example.

#### 3.1.2 Assigning Synaptic Weights

Similarity of any two concepts is given by their co-frequencies of usage relative to individual frequencies, similar to an index of statistical covariance. The concepts generated by similarity analysis serve as the trained network. The concepts represent nodes in the network and the similarities, computed based on co-occurrence analysis, represent asymmetric semantic weights between ideas or concepts (nodes). The synaptic

weight from node  $i$  to node  $j$  is denoted as  $w_{ij}$ . The

relationship between each pair of ideas (nodes or neurons) is expressed as the real-valued asymmetric similarity associated with each pair of ideas. Materially, this is the Hopfield network equivalent of a semantic space.

#### 3.1.3 Initialization

The initial set of recurrent ideas (including repetitive phrases) extracted from a text comments serves as the input pattern. Each node in the network matching one of the extracted concepts from the text comment is initialized to have a value of 1 (i.e., the node is activated), with the rest deactivated, assigned 0 weight, summarized in Equation 1 below:

$$u_i(t_0) = x_i, \quad 0 \leq i \leq n-1 \quad [1]$$

$u_i(t)$  is the output of node  $i$  at time  $t$  and  $x_i$  indicates the input pattern for node  $i$ .

#### 3.1.4 Activation

The nodes contain all important concepts and word combinations from the text. Concurrently, the same network assesses frequencies of occurrence and joint occurrence of different semantic elements within certain structural text units, for example sentences. The resulting graphical structure however does not provide an accurate semantic picture of the analyzed text. An adjustment of the individual statistical weights of the words and relations between them to provide a consistent text representation is needed. The weights of those concepts, strongly related to other frequent concepts in the text should be increased. This is accomplished by assigning the statistical weights of individual concepts to the nodes in the one-dimensional Hopfield with all neurons completely interconnected.

During the activation phase, the statistical weights of relations between concepts are assigned to the links between individual nodes in the semantic network and are permitted to settle. The modified Hopfield network

advances by changing (the weights assigned to the nodes and links between them) to a stable configuration corresponding to the minimum of the Hopfield energy function.

The goal is to obtain the weights  $w_{ij}$  once the network reaches a stable state.

$$u_i(t+1) = f_s \left( \sum_{j=0}^{n-1} w_{ij} u_j(t) \right) \quad [2]$$

$$0 \leq i \leq n-1$$

$f_s$  is the continuous sigmoid transformation function,

$n$  is the number of nodes in the network, and  $net_i$  is the weight computation formula:

$$f_s(net_i) = \frac{1}{1 + \exp\left(\frac{-(net_i - \theta_i)}{\theta_0}\right)} \quad [3]$$

$\theta_i$  is the threshold or bias parameter, and  $\theta_0$  is modifies the shape of the sigmoid function.

$$net_i = \sum_{j=0}^{n-1} w_{ji} u_j(t), \quad [4]$$

The term  $net_i = \sum_{j=0}^{n-1} w_{ji} u_j(t)$  creates a unique feature of the Hopfield net algorithm in that each activated node computes its new weight (output state) based on the summation of the products of its neighboring nodes' weights and the similarity weight between its neighboring nodes and itself.

### 3.1.5 Convergence:

Activation continues until the network reaches a stable state, i.e., there is negligible change in the value of the output states between two time steps. To measure the stability of the network, the difference in activation level between two time steps is computed and compared to a predetermined convergence threshold,  $\epsilon$ :

$$\sum_{i=0}^{n-1} \left| u_i(t+1) - u_i(t) \right| \leq \epsilon \quad [5]$$

The parameter  $\epsilon$  is a threshold used to indicate whether there is a non-negligible overall difference between two consecutive steps, across all network nodes. The final result is the set of concepts having the highest activation level, when the network converges. The resulting concepts (ideas or noun phrases) are considered most relevant to the concepts contained in the semantic space.

## 4. Results and Findings

Eighty-one of the 140 respondents gave input to the question regarding suggestions about how to encourage/promote community development activities on the university campus. The total word count for this file is 2,622 words. Text Analyst 2.0 was applied to the text of word-sentences via as described above. Graphically, the key semantic concepts addressed by the respondents are presented in Figure 1 below.

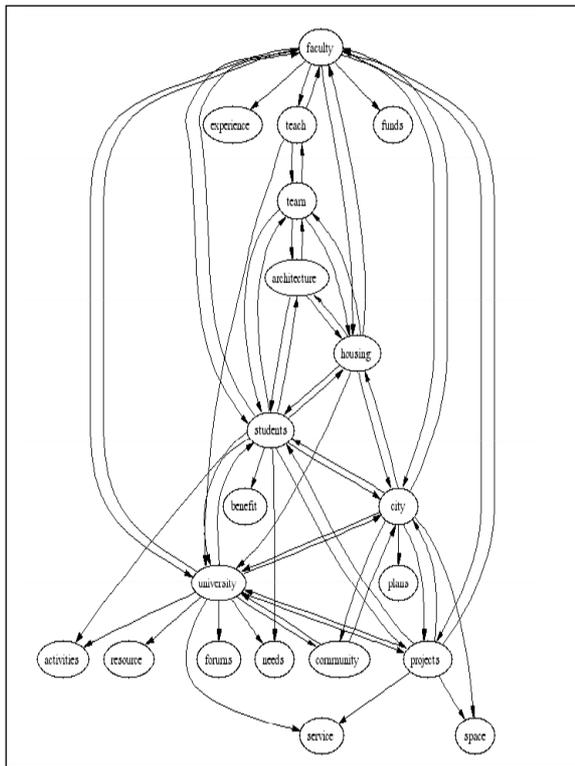


Figure 1: Semantic Map: Ideation Structure For Encouraging Community Development Activities

The above semantic map presents the key concepts contained in the collective text responses to the question regarding suggestions about encouragement and promotion of community development activities by the university community. It is important to note, this map does not necessarily represent any one person, but

rather, represents the collective or group of respondents. The renormalized weights of words and relations between them are called semantic weights and the resulting reshaped graph-like structure is called a semantic network (which is a list of the most important words and word combinations from the text and relations between them).

A 261-word summary of the total set of text responses is presented below. Note this summary yields highly actionable managerial information:

“The university should interact more with the city to reach mutually beneficial solutions to employment, housing for faculty and students and community development. Continue to provide a forum for discussion of issues between the university community and the city community at large: Outreach projects, which have visible impact. Volunteers who perform services for the needy, university learning projects which enhance quality of life for community, Opening up university resources to community. Allow more local businesses to have commercial activities on university.

I would be interested in team teaching a collaborative course with business, architecture, city and Regional Planning and Landscape architecture students and Faculty on investigating housing design for families, elderly and students.

I would like to develop team-based senior projects (ideally jointly between College of Business, and [local research park] and college of architecture students) to study housing options for the elderly, for instance, and develop viable proposals for housing facilities which will fill the gaps in the current market.

We need a lecture series that brings California and Western practitioners to university to share their experiences with the faculty.

We need a 'faculty brown bag' series that allows faculty and students to come together and share local experiences

University needs to hold forums on relevant topics. Perhaps these initiatives could be tied together with a multidisciplinary forum on community development where university faculty and staff as well as outside speakers could be invited to share their experience and expertise on issues related to community development.

Extended Studies is a logical resource for promoting community development activities on our university.”

#### 4.1. Managerial Implications

To encourage community development activities on campus and local community, the content of the survey focused on thoughts, suggestions, and opinions regarding the startup and operation of a community development center at a major U.S. University. The key relational ideas expressed in the group’s responses are presented below.

University and city interaction regarding

- Housing for faculty and students
- Services for the needy
- Quality of community life
- Opening university resources
- More local business activities on campus

Actions within the university to focus on

- Team teaching
- Investigation of housing for the elderly and students populations
- Increased relations with local research park
- Encouraging practitioners to share experience with faculty and students
- Lecture series
- Faculty “brown bag” seminars
- University sponsored forums
- Use of extended studies programs

#### References

- [1] Bonnet, A. *Artificial Intelligence: Promise and Performance*, Prentice-Hall International, U.K., 1985.
- [2] Dalton, J and A. Deshmane, “Artificial neural networks,” *IEEE Potentials*, 1991, 10 (April, 2): 33-36, 1001.
- [3] Chung, Yi-Ming, W. M. Pottenger, and B. R. Schatz. ”Automatic Subjective Indexing Using An Associative Neutral Network,” *Association of Computing Machinery, Digital Library, ACM DL*, 1998, 59-68.
- [4] Hopfield, J. J. ”Neural network and physical systems with collective computational abilities,” *Proceedings of the National Academy of Sciences, USA*, 1982, 79(4):2554-2558.
- [5] Knight, K. “Connectionist ideas and algorithms,” *Communications of the ACM*, 33, 1990, (November, 11): 59-74.
- [6] Tank, D. W. and J. J. Hopfield. ”Collective computation in neuron like circuits,” *Scientific American*, 1987, 257(December 6): 104-114.
- [7] Quillian, M .R. “Semantic memory”, in *Semantic Information Processing*, M. Minsky (ed.), 1968, Cambridge, Mass, MIT Press, 227-270.

# Knowledge Discovery Model in Chinese Industrial News

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## Abstract

With prevalence of Internet, users can easily retrieve the information what they want from Internet. Information explosion shows that efficient information summarization is aspired to all users. Therefore, an efficient knowledge management methodology becomes very important. Some technologies, such as text mining, for acquiring knowledge from huge amount of electronic documents are recognized as important technology in this field.

This work focuses on text-mining applications on Chinese industrial news and knowledge discovery. We use information extract method to extract news into companies, event keyword, time, location, and person categories based on the characteristics of news. The set of five extracted categories is called information template. The templates are summarized by rule induction. We can discover unexpected knowledge from these summarized rules. We built an integrated industrial news text-mining model by using induction rule learner. This model is suitable to manipulate rules in bag-of-word form. Furthermore, we proposed interestingness to measure interesting strength of rules. The users can analyze the discovered rules based this measure. These are helpful to discover unexpected knowledge. It is meaningful to commercial activities if we can discover valuable rules. Besides industrial news application, we believe this model is suitable for knowledge discovery application in other fields.

## 1. Introduction

With prevalence of Internet, users can easily retrieve the information what they want from Internet. Unfortunately, people could not promptly acquire knowledge from this information source without computer processing technology. Therefore, an efficient knowledge extraction technology becomes very important. Text mining is recognized as one of the most important technologies for discovering knowledge from huge amount of electronic documents. In recent years, the technologies of knowledge discovery from database (KDD) have been well developed. Most researchers proposed text-mining

models based on well-developed data mining technologies [7]. The purpose of knowledge discovery is to extract implicit, unknown, and unexpected information [2].

Figure 1 depicts a text-mining model extended from data mining. In order to transform ordinary text document into predefined database, an information extraction (IE) process is developed to extract necessary information from text documents. IE process involves natural language process technologies [3]. After transforming unstructured text documents into structured information database, the system applies suitable data-mining technologies to post-process the extracted information for completing knowledge discovery.

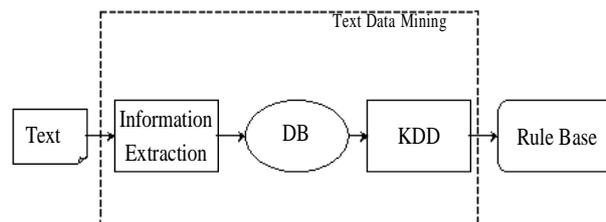


Figure 1 Text-mining model extended from data mining [7]

Text mining is to discover useful information pattern from huge amount of electronic documents. The discovered information pattern can be transformed into specific knowledge presentation form. Once the extract information can be transformed into knowledge presentation database, we achieve the knowledge discovery purpose. In this study, we focus on industry related news report. We applied mutual information (MI) technology to segment Chinese text document into phrases and statistical method to select keywords of the text documents. The extracted information is transformed into predefined rule templates to represent the extracted knowledge fact. The extracted rule templates are stored in database and we applied knowledge discovery technologies, namely rule learners, to discover unexpected knowledge rule form the database. The produced knowledge rules are stored in database. As a result, our knowledge

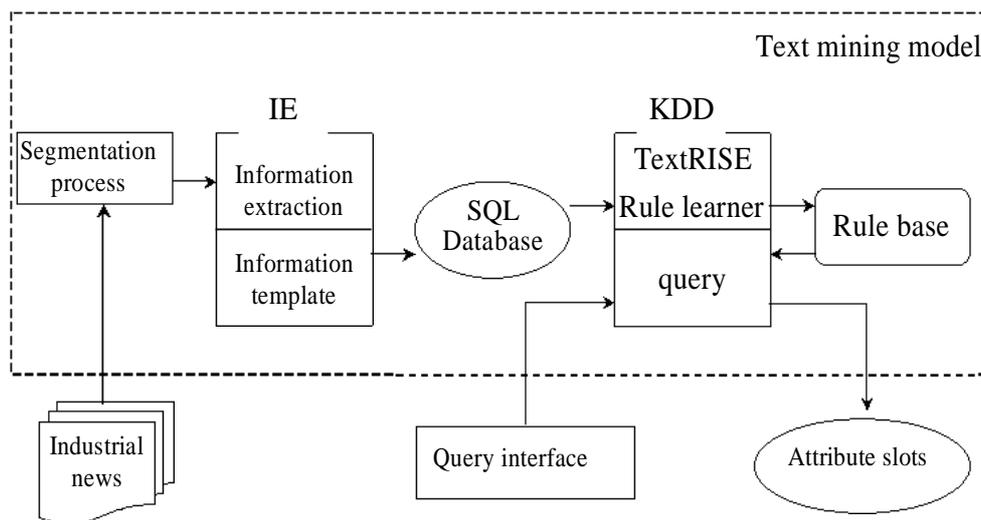


Figure 2 The knowledge discovery model in Chinese Industrial News

database is created and offers convenient query interface for knowledge rule querying. We have to remind readers that not every minded knowledge rule is interesting to all users. Furthermore, we introduced a measure, interestingness, to help users find out the knowledge rules what they are interested.

In Section 2, we introduce our Knowledge Discovery model in Chinese industrial news with text-mining. The globalview of the proposed model is discussed. The detail discussion of the text preprocess is shown in Section 3. In section 4, we discuss the rule learner algorithm TextRise what we use in our model in detail. We introduced the interestingness measure in Section 5.

## 2. The Knowledge Discovery Model in Chinese Industrial News

In this section, we give the global view of the knowledge discovery model in Chinese industrial news. Our knowledge discovery model is derived from the general text data mining model which is discussed in previous section. As shown in Figure 2, the model is divided in two parts: pre-process and post-process. The pre-process part takes the Chinese news reports are input data. The pre-processes include Chinese segmentation and information extraction. The extracted information is stored in predefined format database to represent the knowledge template. The post-process, KDD, part is applied a rule learner, named TextRise, to induce the knowledge templates into a set of rule base. The users find out the interesting or helpful knowledge rules aided by a proposed measure, interestingness, from the rule set. In such a way, the users can easily find out useful knowledge or information without reading huge

amount of text documents from Internet or other sources.

Unlike pre-process for English text documents, Chinese text documents are composited from Chinese characters without spaces. The process to divide Chinese text into segments, or phrases, are called segmentation process. There are three major approaches for Chinese segmentation. The first approach is dictionary-base with maximum matching. That is, the process segments Chinese text by looking up a pre-defined Chinese dictionary. In general, the process takes the phrase with maximum length from all candidate phrases. The second approach is based on statistical methodology. The system uses a pre-produced characters mutual information database to divide Chinese text into proper phrases. The character mutual information is a statistical information from an exist corpus. The third approach integrates the first two approached to have both advantages of these two approaches. We use the third approach as part of our Chinese text segmentation process. We will discuss the segmentation in detail in next section.

The information extraction categorizes the segmented phrases into pre-defined bags of words, or BOWs, and stores the extracted information into database. We called the set of categories as knowledge template. The post-process of our model uses a rule learner TextRise to induce the knowledge template into knowledge rule base. The TextRise is suitable to process rule representation we use. The rule learner is designed for BOW-base rule learning. Actually, the users are not interested to all mined rules. We introduce a measure interestingness to help users find out knowledge rules what they are interested. We shall discuss this part in Section 4.

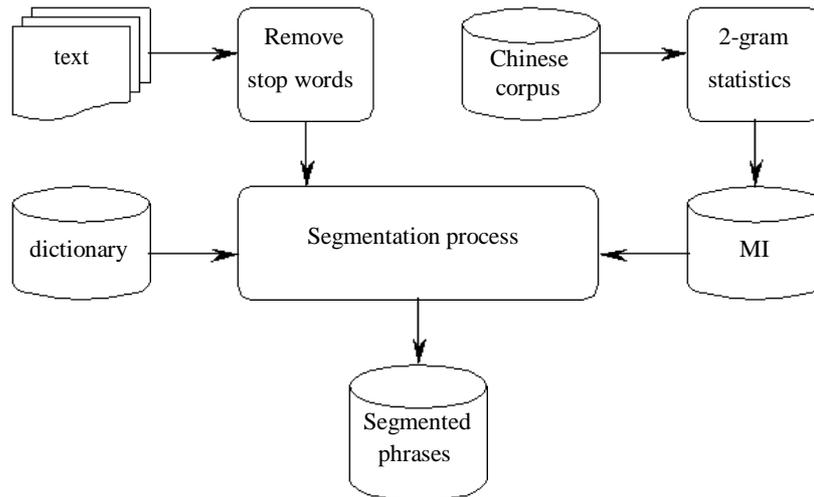


Figure 3 The integrated Chinese segmentation process

### 3. The Chinese segmentation and information extraction

Figure 3 depicts our integrated Chinese segmentation process in the proposed model. We prepared Chinese character mutual information from huge amount of Chinese corpus. We also prepared a Chinese stop word list for removing meaningless Chinese stop words first. In the segmentation process, we use dictionary-base and MI-base to segment the same text. The segmentation process takes the longest phrase as a result.

We use Sporat and Shih’s approach [9] to calculate the Chinese mutual information (MI). The MI measure represents the concatenation strength of two Chinese character a and b. The MI value is calculated by equation (1):

$$MI(ab) = \log_2(N) + \log_2 \frac{f(ab)}{f(a) \times f(b)} \quad (1)$$

where Chinese character b appears after character a.  $f(ab)$  represents the times what character b appears after character a.  $f(a)$  and  $f(b)$  represent the appearing times of character a and b respectively. N is the total number of Chinese characters in the corpus. Chinese phrase ab could be a Chinese phrase if their MI value is high. Chinese character sequence abc could be highly possible a true Chinese phrase if both  $MI(ab)$  and  $MI(bc)$  are high. In such a way, we can possibly find a new n-gram phrase. This approach solves the deficiency of phrase-base segmentation approach for new phrase. For example, we find that

the both  $MI(\text{范巽})$  and  $MI(\text{巽綠})$  are high, 15.9 and 14.4 respectively, and 3-gram “范巽綠” is not in our dictionary. Due to the high MI values of both bi-gram “范巽” and “巽綠”, our segmentation process can successfully segment the present Taiwan vice-minister of education “范巽綠”.

Table 1 Example of finding new Chinese phrase

bi-gram	MI value
長范	4.8009
范巽	15.9413
巽綠	14.4544

After segmentation process, information process categories all segmented phrases into pre-defined BOWs and form rule templates. The definition of BOWs is based on the characteristics of processed text documents. In this work, we are interested in text-mining application of industrial news reports. We categorize the phrases into five BOWs, namely people, company, location, time, and event. Table 2 shows such an possible template example which is extracted from an industrial new report.

Table 2 The template example

Bag of words	Contents
Company	文化公司
Event	股票上市、開高走高
Time	民國89 年第3 季
Location	文化資訊公司
People	王財得、林大義

#### 4. The TextRise algorithm

The TextRise is derived from Rise algorithm [8]. In order to process text information, the rule distance is calculated as the text similarity. The TextRise algorithm is shown in Figure 4. The algorithm uses TextAccuracy value to determine whether to terminate the induction process or not. The TextAccuracy is defined as the average accuracy of rule set to the given example set. The algorithm stops when none of rule generalization can improve the TextAccuracy of rule set on given example set.

```

Input: ES is the training set.
Output: RS is the rule set.
Function TextRISE (ES)
RS := ES.
Compute TextAccuracy (RS,ES).
Repeat
For each rule R∈ RS,
    Ê:=arg max Similaity(E,R)
        E∈ES'
    where ES' = { E':E' ∈ES and E' is not covered by R}
    R':=Most_Specific_Generalization(R, Ê)
    RS':=RS with R replaced by R'
    If TextAccuracy(RS',ES)≥TextAccuracy(RS,ES)
        Then RS:=RS'
        If R' is identical to another rule in RS,
            Then delete R' from RS.
Until no increase in TextAccuracy(RS,ES) is obtained
Return RS.
    
```

Figure 4 The TextRise algorithm [8]

We have to remind readers that the size of the produced rule set is smaller than size of the given example set. The new generalized rule may be pruned if there exists identical rule in present rule set.

#### 5. Interestingness measure

The induction rule base produced from the TextRise will be huge when the system processes mass amount of text news reports. We introduce an interestingness measure to help users finding valuable knowledge from our system. Actually, a single rule in the rule base may not be interesting to everybody. We define the proposed interestingness measure as:

$$I(k, \tau) = \frac{|\{b \in D \mid \forall A_i, a_i, \text{sim}(A_i, a_i) \geq \tau, \text{sim}(C, c) \geq \tau\}|}{|\{b \in D \mid \forall A_i, a_i, \text{sim}(A_i, a_i) \geq \tau\}|} \quad (2)$$

where  $k \equiv A \rightarrow C$  is a predicate rule. A is antecedence of the predicate rule k, and C is the consequence. D is the knowledge rule base produced by our system. The  $\tau$  is the user given threshold. The predicate rule k is interesting to user if its interestingness measure is high. Otherwise, the rule is useless to a user.

Figure 5 depicts an interestingness query example. The query result is shown in Figure 6. The example shows query about “information consumer electrical products”. The system returns four related rules from rule base with their interestingness measure.

#### 6. Conclusion

In this study, we propose an automatic knowledge discovery model in Chinese Industrial news with text mining. The proposed model can process mass amount of Chinese text documents and induce them into knowledge rule base. The major contributions are:

1. Define a useful measure, interestingness, to help users find out the useful or unexpected knowledge from our rule base.
2. The system can automatically process mass amount of electronic Chinese text documents. The system induces these documents into knowledge rule base. Such that, the users can easily discover knowledge by query the rule base.
3. Using bag of words has better and complete knowledge representation.

Our approach is not only for industrial news reports. It is also suitable for other field of text documents if we can properly define the bags of words for the specific field. The post-process of the proposed model can be applied other approach to produce better knowledge database. The neural fuzzy might be a possible approach to replace the TextRise algorithm.

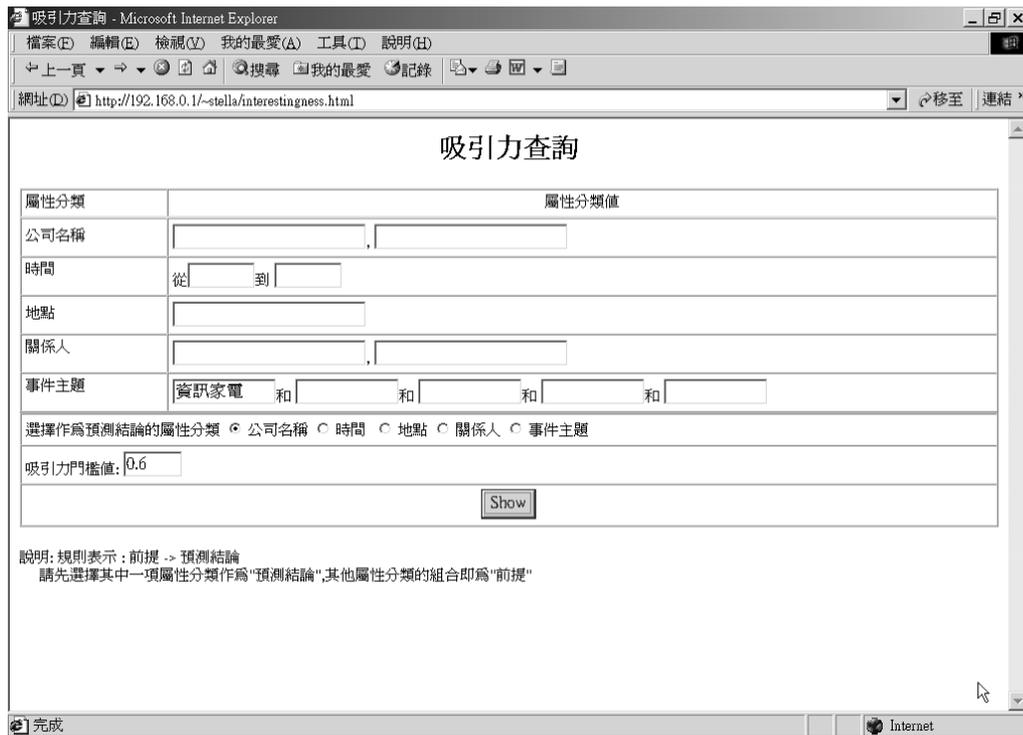


Figure 5 The interestingness query example



Figure 6 The interestingness query result

## References

- [1] Berson, A., Smith, S., & Thearling, K. (2000), *Building Data Mining Applications for CRM*, The McGraw-Hill Companies, New York.
- [2] Brachman, R. J., & Anand, T. (1996). In U. M. Fayyad, G. Piatetsky-Shapiro, P. Smyth, & R. Uthurusamy (Eds.), *Advances in knowledge discovery and data mining: The process of knowledge discovery in databases* (pp.38-56). AAAI Press / The MIT Press, Menlo Park, California.
- [3] DeJong, G. (1982). An overview of the frump system. In W. B. Lehnert & M. H. Ringle (Eds.), *Proceedings of Strategies for Natural Language Processing* (pp. 149-176), Erlbaum.
- [4] Hsu, C. C., & Chen, J. K. (2001). Data Mining in Chinese News Articles, *Journal of Information Management*,7(2), 103-122.
- [5] Hu, S. J. & Hsu, C. C. (1999), Word Segmentation in Chinese News Articles, *Proceedings of the 10th International Conference on Information Management*, (pp. 968-974), Taiwan.
- [6] Huang, J. Y., Lee H. M., & Chen, W. Y. (2001), Industrial News Knowledge Discovery with Text Mining Approach, *Proceedings of the 7th Conference on Information Management and Practice(CSIM2001)[CD-ROM]*, Taipei, Taiwan.
- [7] Nahm, U. Y., & Mooney, R. J. (2000). Using information extraction to aid the discovery of prediction rules from text. In KDD Committee (Ed.), *Proceedings of the KDD-2000 Workshop on Text Mining* (pp. 51-58), Boston, Massachusetts.
- [8] Nahm, U. Y., & Mooney, R. J. (2001). Mining soft-matching rules from textual data. In IJCAI Committee (Ed.), *Proceedings of the 17th International Joint Conference on Artificial Intelligence (IJCAI-01)* (pp. 979-984), Seattle, Washington.
- [9] Sporat, R., & Shih, C. (1990). A statistical method for finding word boundaries in Chinese text. *Computer Processing of Chinese and Oriental Languages*, 4(4), 336-351.

# A Curriculum Development project for IBM Linux in Academia Program

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## Abstract

This paper introduces the IBM Linux in Academia program and a curriculum development project initiated by the authors for the program. The service of IBM Linux in Academia program is based on the Linux virtual service concept in which a mainframe computer is partitioned into many Linux images supported by IBM's Virtual Machine Operating System. On the IBM S/390 system, each image acts as an independent Linux server. This free service saves the acquisition and management cost of running multiple physically separated servers for participating universities. The curriculum development project intends to create and share curriculum materials for e-Business related courses among participants. The main IBM software used in this project includes DB2 Universal Database and WebSphere. The main objective in the first stage of this project is to develop a data warehouse generator to manipulate a large read-only database obtained from a real world health care application supplied by IBM. Through a web based user interface, an instructor could flexibly create a data warehouse using the Account Data Model developed by some of the authors from the read-only database with the desirable size and attributes to support pedagogical needs. Other aspects of the project are also addressed.

**key words:** Account Data Model, Data Warehousing, DB2, Linux, WebSphere

## 1 Introduction

The objective of the IBM Linux in Academia program is to provide a robust and reliable Linux environment for the university community dedicated to educational and research purposes [2]. The service provided by the program is hosted on an IBM S/390 mainframe computer located at Colorado State University, capable of running hundreds of Linux images (servers) on the same hub server at the same time. The hub server partitions the necessary processing, storage and network capacity for each Linux image. As a result, resources can be allocated flexibly to meet the individual need of an image while maintaining the same level

of separation between images as any physically separated servers would. A commercial service based on the same concept was launched by IBM recently [6]. The Linux in Academia program allows a participating university free accesses to not only IBM software packages but also virtual servers to host those applications. The major benefit to a participating educational institution from this arrangement is that the institution could offer its instructors and students accesses to the state-of-the-art information technologies without heavy investment in IT infrastructure. The service is especially valuable to colleges without adequate financial and human resources to acquire and manage the hardware and software required to support their IT related curricula. In addition to the common open source packages for Linux, the two major IBM software components included in this service are DB2 Universal Database and WebSphere.

Despite the abundant resources provided by the Linux in Academia program, the service does not include instructional resources such as course materials and sample databases. This might not pose a serious problem for a Computer Science program which may require students to build software and network applications on a Linux image from scratch. As the need of a business program, MBA in particular, focuses more on utilizing existing databases for the purpose of training students on analytical skills (marketing research, customer relationship management) and managerial concepts (e-Business strategies), there is a demand for instructional materials, especially those supported by a user friendly interface for students without programming experience. The Business School at the State University of New York at New Paltz (hereafter referred to as SUNY-NP) signed a collaboration agreement with IBM on October 26, 2001, to establish an e-Business Virtual Lab using the service from the Linux in Academia program. As the first business program participating in the Academia program, the authors propose a project to develop course materials for the program. We hope the instructional resources developed from the project could encourage more colleges to join the Linux in Academia program which in turn helps the program develop and test more contents.

The core of the project is to develop a framework

and all associated software so that an instructor could easily extract and build a customized data warehouse from a large read-only database (57 GBytes) for his or her instructional need on the instructor's own Linux image. This read-only database is structured using a popular data model for data warehouses, namely the star schema. As a result, extracting a small portion from the large database is relatively easy. However, we would like to take this opportunity to test a new data model, Account Data Model (see [7] for details), as the data model for warehousing purposes due to its flexibility. The extracted data warehouse is created from the dimensions and attribute values chosen by the instructor. For example, the instructor may select a shorter period of time or a focused subset of geographical regions to control the size of the resulting data warehouse. The instructor has full privilege to the resulting database and could control the privileges rendered to his/her students. The read-only database is provided by IBM from a real world application in health care (medical insurance) industry with all personal and institutional identities removed or disguised. The size of the extracted data warehouse on the instructor's image is targeted at 2 GBytes, which we believe can still give students a flavor of a realistic data warehouse with considerable size. As transmitting 2 GByte data on the Internet can be very time consuming, the Academia program provides a perfect platform for us to implement this project. Although the read-only database is installed on a Linux image which is logically separated and independent from the instructor's image, both are physically located on the same S/390 system. This configuration significantly reduces the download time. Using a web based GUI interface, the process of creating the instructional data warehouse is reduced to clicking on the desired attribute values presented in a tree structure similar to a file/directory navigating system such as Windows Explorer. Additional web based user interface for students to access the data warehouse on their instructor's image is also intended for reducing the level of computer skills needed to query the database. Those user interfaces will be built on common open source software and be organized and managed by IBM's WebSphere.

The following sections provide more detailed introduction and descriptions of the infrastructure of the Academia program and our plan of supporting this service with course contents developed from this curriculum development project.

## 2 Infrastructure of IBM Linux in Academia Program

The service of the Linux in Academia program is based on the "utility computing" concept advocated by major UNIX server vendors including IBM, HP, and Sun Microsystems. They argue that the computing resources do not necessarily need to reside in the user's

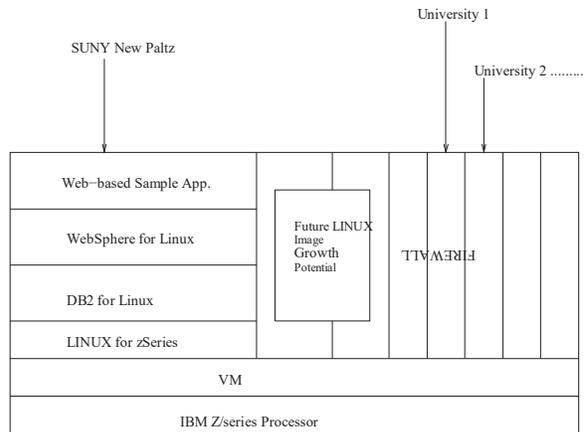


Figure 1: Linux Images on S390

organization. Instead they can be outsourced to a remote server managed by a vendor to save management costs on maintaining system hardware, software, security, and reliability, etc. The organization only needs to maintain lean clients to tap into the utility system. The Academia program has setup its Linux hub at Colorado State University on an IBM S/390 mainframe running a Virtual Machine (VM) operating system which supports the partition of system resources to host many virtual servers (images) each running a Linux (for S/390) operating system. Figure 1 illustrates the architecture of the system. The two layers at the bottom are the zSeries processor and the VM operating system for the S/390. The top four layers on the left demonstrates a sample Linux image created for SUNY-NP. At the foundation of this image is a SuSE version of Linux for S/390 and the middleware includes a DB2 Universal Database Server and a WebSphere Server on which web based applications (top layer) can be built. The other side shows potential future images. These images act like independent servers protected by their own firewalls. For a Computer Networking course, each student may obtain an image of his/her own with small disk space. For an e-Business course offered by a business school to students with limited computer experience, the whole class may share an image having much bigger memory and disk space than those images created for individuals. Thus, an image can be created to serve the need of a course, a user, or an application area with the desired software packages, computing power and storage space.

Accesses to the Linux images are provided via three channels as listed below.

- An end user either on or off campus can connect to the campus LAN which in turn connects to the server through a secure VPN session.
- A user could also access the image directly through an internet Secured Shell (SSH) connection.

- A user can use a browser to access a password protected web sites as a gateway to the resources and applications on various Linux images.

Software packages such as Putty and WinSCP2 are ideal tool to access Linux images through a secured shell (SSH). Both programs are small and do not require installation. This is particularly convenient for students to carry them in a floppy disk and work on different locations. However, the easiest way to access an application for non-computer savvies on a Linux image is to do it through a web browser which is available almost everywhere. As a result, this is the approach we recommend for our business students.

### 3 Potential Curriculum Supports

There are many areas and courses that can utilize the service and its contents. We discuss a few potential areas in this section.

*Data Analysis:* In courses like Marketing Research and Decision Support Systems, students can access a read-only database created by their instructors and retrieve necessary data through a browser on selected dimensions and ranges of attribute values. The interface translates the user's request into a SQL SELECT statement and connect to the data warehouse to get the data which is saved as a file in the user's account. The student can then download the resulting data set to local machines for further analysis. This application is also suitable for covering course subjects such as data mining and customer relationship management. The instructor can observe and discuss the different viewpoints and conclusions generated by students from the same database and demonstrate the benefit obtained from such analysis.

*Virtual Company:* Students create their own small databases with full access privilege to store product, customer, and order information for their virtual companies. This exercise involves students from the design phase of setting up an information system for a company. Students are asked to consider the issues of how their designs can help the organization achieve its strategic goals and manage daily operations. The instructor can address the importance of design issues related to a MIS project and how a well designed information system can facilitate business decision processes, which in turn enhance an organization's competitive advantages.

*Virtual Community:* The first two applications focus more on the database issue which is the building block for other e-Business applications. The virtual community application extends the database built earlier to create an online community by connecting the virtual companies from various students together. For example, a manufacturer wants to purchase materials online from its supplier and a bank handles the payment between the manufacturer and the supplier. Students can team up with Computer Science majors on these web

application projects to develop their first e-Business practice, which handles online transactions and update their databases. This service can be provided either by the Apache web server with CGI supports or from a fully integrated software for e-Business such as IBM WebSphere.

One concern we have at this point is the internet traffic during peak hours. During certain time of the day, the connection to the hub may be much slower. In that case, the instructor may consider installing a local copy of the application to support instructional purposes. For example, the instructor can further extract a 2 MByte data warehouse from the 2 GByte data warehouse on his/her image to a local Linux server (DB2 is available through IBM Scholar program for local installation). Students may practice and prototype their work on the local server during internet peak hours and submit their pretested queries to the 2 GByte warehouse for their project later.

### 4 The Medical Insurance Database

In this section, we introduce the Medical Insurance database used in this project. This database is a database used by IBM for software testing purposes. It is obtained from a real practice at a health insurance company. All sensitive information is either removed or disguised in this database. The database is structured under a popular data model for data warehouses, namely, the *star schema*. As a result, understanding the meaning of attributes and writing queries against it are relatively easy. The data warehouse only contains one year medical insurance claim data which already consumes 57 GByte hard disk space on a Linux image.

At the center of this data warehouse sits a fact table, INS700TB, which records detailed insurance claim history. The metrics in this fact table are dollar amount and frequencies of insurance claims, including measures such as payment amount, deductible amount, coinsurance amount, third party payment amount, and claim utilization counts, etc. This table has 228,221,751 rows. There are 11 dimension tables as follows.

1. INS002TB: Each row in this table represents an individual who enrolled in this insurance policy (1,428,826 rows).
2. INS800TB: This table stores 15,186 different diagnosis categories (15,186 rows).
3. INS801TB: Diagnosis are also classified into 512 diagnosis related groups (512 rows).
4. INS804TB: There are 19 different reasons for discharging a patient from a hospital stay (19 rows).
5. INS805TB: This is a list of states where the patient resides. It covers all fifty states of the United States (50 rows).
6. INS806TB: All claims are classified into 5 different types (5 rows).

7. INS808TB: This table lists the year when services are provided. Since we only have one-year data, this dimension table has no effect on any query results.
8. INS809TB: This table records all month and year combination during the one-year period (12 rows).
9. INS810TB: This table records the month/date/year and month/year combinations for the recorded period (365 rows).
10. INS811TB: There are 4275 different medical procedures (4275 rows).
11. INS812TB: This table records the provider's locations which include the 50 US states, the identification and short name of the state, and some foreign countries or regions (132 rows).

In addition to the main fact table, there are 5 summary tables with higher level of aggregation. Therefore, their sizes are much smaller.

1. INS750TB: This table summarizes the utilization of the insurance policy by patient state, year, month, and claim types (2998 rows).
2. INS751TB: This is a summary of utilization by providers, provider state, year, month, and claim types (2998 rows).
3. INS752TB: This is a summary of service grouped by diagnosis, diagnosis related group, patient state, and primary procedure performed, year, month, and claim types (7,811,520 rows).
4. INS752TB: This is a summary by claim type and year (5 rows).
5. INS756TB: This is a summary by provider state and year. It has 51 rows, one for each of the 50 states and the remaining one for the sum of all non-US countries and areas.

The number of dimensions for those summary tables is also smaller, ranging from two to seven. Due to the fact that we are only given one year data, the year dimension (INS808TB) is irrelevant in this case. Nevertheless, we still retain this dimension to preserve the overall structure of the data warehouse. The main fact table, INS700TB is the most detailed one which has all dimension tables except for INS808TB as its star dimensions. Summary table INS750 has four dimension tables including

1. INS805TB (50)
2. INS806TB (5)
3. INS808TB (1)
4. INS809TB (12)

Numbers in the parentheses indicate the number of rows in each table. Figure 2 shows the dot model for summary table INS751TB. The dot model is centered at table INS751TB, its fact table, and four dimension tables INS806TB, INS808TB, INS809TB,

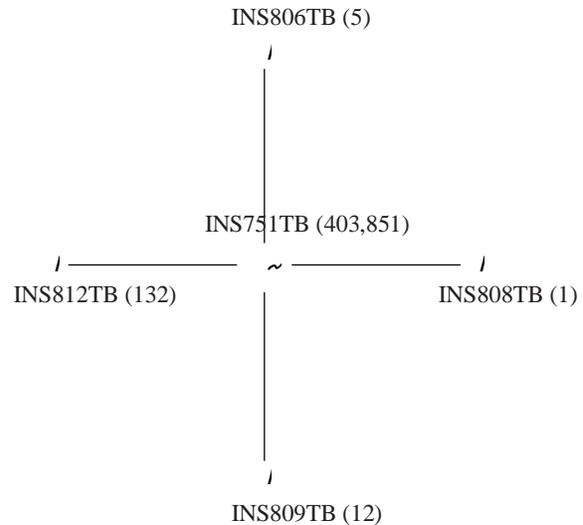


Figure 2: Dot Model for INS751TB

and INS812TB, which maintain one-to-many relationship with the fact table. Summary table INS752TB (7,811,520) has seven dimension tables as shown below.

1. INS800TB (15,186)
2. INS801TB (512)
3. INS805TB (50)
4. INS806TB (6)
5. INS808 (1)
6. INS809TB (12)
7. INS811TB (4,275)

Summary table INS853TB (5) is joined by two dimension tables INS808TB (6) and INS808TB (5). Tables INS808TB (1) and INS812TB (132) are the dimension tables for INS756TB (51) which summarizes the claim amount and frequencies by providers' locations with all non-US locations aggregated into one row.

Those tables and their indices take about 57 GByte of disk space. Table INS700TB alone occupies more than half of that space and due to its size, has to be separated into 30 containers. We also observe that the design of this data warehouse follows a practice suggested by some practitioners, i.e., having a main fact table accompanied by a half dozen summary tables [8] to shorten response time on frequently requested queries about highly aggregated information.

## 5 The Account Data Model

In this section, we briefly introduce the Account Data Model (ADM) used in our data warehousing component of the project. Detailed discussion of the model can be found in Pletch, *et al.* [7]. In most of database implementations, the transaction support

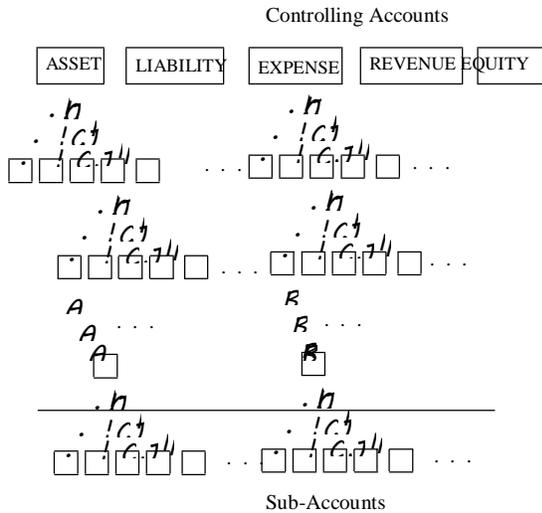


Figure 3: An Account Hierarchy

database and decision support database (data warehouse) are built based on separate data models. The most popular data model for the former is the Entity Relationship (ER) Model [1] and the latter usually adopts a dimensional model with a star schema or a snowflake schema [5]. In our database design, the transactional and warehousing databases are integrated using the same data model, the ADM. From a data warehousing perspective, this data model can be viewed as a special case of a snowflake schema in which there is only one table joined to the fact table that specifies the type of account each row of the fact table belongs to. It uses a hierarchy of accounts to model the information found in an organization's transactional as well as decision support processing. Most of this hierarchy follows standard double-entry accounting practices, i.e. a set of accounts organized in sub-trees rooted in five major accounting categories, namely ASSET, LIABILITY, EQUITY, REVENUE, and EXPENSES. The leaf nodes in Figure 3 represented by boxes below the solid line are called sub-accounts. They are the only accounts which actually participate in transactions and are the ones that link to the fact table from a warehousing perspective. Boxes above the solid line (referred to as controlling accounts) form a type hierarchy and are used as summary accounts, summarizing the activity of the accounts below them in the hierarchy.

Following accounting practices, a transaction is a collection of components that document either debit or credit operations against accounts. Transactions should be *balanced* in that every crediting component is offset by a corresponding debiting component. Ensuring that transactions are balanced before they are accepted pushes some of the data cleansing activity typical of the migration of data from an ER-based database to a data warehouse into the data entry phase. However, unlike the ER model, the design of the hierar-

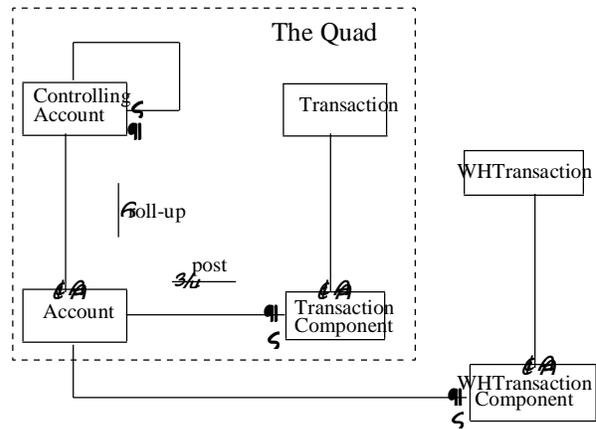


Figure 4: The Quad with Data Warehouse Extension

chical account structure is less intuitive and requires better understanding of the business side of the organization. Nevertheless, a well designed account hierarchy serves as a good managerial tool for companies wanting to practice the principles of the Balanced Scorecard [4] which requires measuring performances from four interrelated categories. This is due to the fact that the design process forces a designer to create accounts which could also represent performance measures. In addition, the double entry system guarantees that an activity is viewed at least from two perspectives. The two entries can also be used to track the links or causal relationship between two performance measures. The pain of designing the hierarchy can somewhat be eased by adopting the standard charts of accounts developed by specific industries.

Part of the justification of our claim that an ADM implementation can be used as a data warehouse is our confidence in the quality of the data stored due to the balanced-transaction nature of the model. Transactions and transaction components along with accounts and controlling accounts eventually come to reside in a standard four-table structure as shown in the dashed box of Figure 4. We refer to this table structure as the *Quad*. Each transaction involves a row in the transaction table and several rows in the transaction component table. A typical transaction can be better described using the following example.

**Example 5.1** A customer, XYZ, orders four units of widget at the unit price of \$15 and unit cost of \$10 on July 15, 2002.

The event in Example 5.1 generates the following accounting entries.

- |   |                                |      |      |
|---|--------------------------------|------|------|
| □ | (a) Account Receivable-XYZ Co. | \$60 |      |
| □ | (b) Sales-XYZ Co.              |      | \$60 |
| □ | (c) Cost of good Sold-widget   | \$40 |      |
| □ | (d) Inventory-widget           |      | \$40 |
- (1)

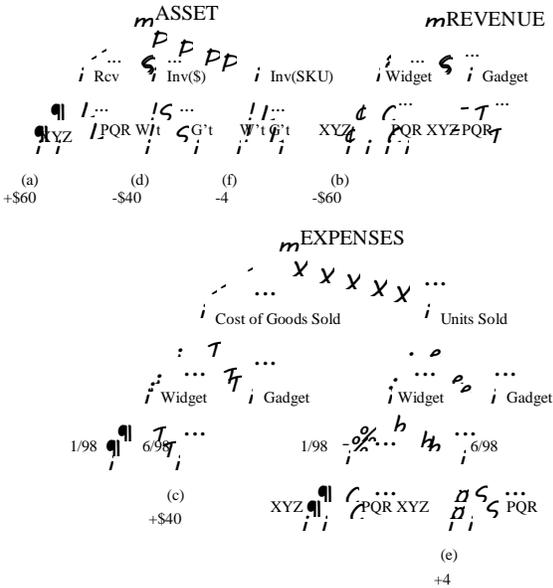


Figure 5: The Components in Accounting Trees

In addition, two inventory entries are also recorded for this event, one debited four units of widgets into customer XYZ's account and the other credited four units from the inventory account of widgets as shown in the following entries.

$\frac{1}{2}$	(e) Units sold -XYZ Co./widget	4	(2)
	(f) Inventory - widget	4	

One row is added to the Transaction table in Figure 4 to represent this transaction. The six accounting entries correspond to six transaction components, half of them debiting accounts and the other half crediting accounts. Hence, six rows are added to the Transaction Component table of Figure 4.

At some point after a transaction has been entered, it undergoes a process called *posting* which updates the sub-accounts in the account table affected by the new transaction. These modifications are further propagated to the controlling accounts (rows in the Controlling Account table) higher up the account hierarchy from the affected sub-accounts by a process called *roll-up*. Both these activities are indicated diagrammatically in Figure 4. When these components are posted, we see the changes in Figure 5 to the balances of the six affected sub-accounts. Note that the negative values under inventory and inventory SKU (Stock Keeping Units) in the figure come from debiting a credit account (or crediting a debit account). Both posting and roll-up become part of the model through automated means - stored procedures, triggers and the like.

The ADM does not support modifying or deleting an existing Quad transaction directly. When a business activity, a sales order for example, is later modified the ADM implements this modification by adding

a totally new transaction. The net effect of combining the components in the new transaction and the original transaction produces new account balances. Thus the original transaction and a corresponding modifying transaction provide a history of the ordering process. From a process point of view, every possible change to an account must be kept for the purpose of process control.

The two tables not in the dashed box of Figure 4 are used specifically for warehousing (decision support) purposes, the WHTransaction and WHTransaction Component tables share exactly the same format as their transactional support counter parts, Transaction table and Transaction Component table. As we use the same data model for the two, they share the same Account and Controlling Account tables. In fact, some of the performance measures from the Financial category of a balanced scorecard may have already been built into the Quad in the transactional support part of the Quad while the performance measures from the remaining three categories (customers, internal business process, learning and growth) are generated for decision support purposes. The warehouse version of the Transaction Component table may choose to keep only the net result of a transaction after it has been fulfilled.

The ADM shows its true strength in its ability to add new information about any transactional and warehousing applications without the need for table redesign. This is achieved by adding new accounts and sub-accounts for the new attributes and entities and then, for each type of affected transaction, additional transaction components are generated to support debiting or crediting the new accounts. In such cases we add more rows to existing tables; never more columns nor more tables. Indeed in the current implementation, transactions saved under an old design schema, which is then redesigned to affect different sub-accounts, will automatically reflect the new design simply by being brought into the user-interface and saved again without change. This is particularly useful if changes of design are needed to reflect new business processes or performance measures. What makes the ADM a viable data warehousing model is the fact that all transactional and decision support components are stored in the same table structures. Adding new types of transactions or even modifying the design of existing transactions becomes a data-entry activity rather than a design endeavor. Thus the line between the transactional database and data warehouse becomes blurry.

## 6 The Data Warehousing Component of the Project

Universities throughout the world often need access to large databases for various pedagogical reasons. In educational programs such as Computer Science where students are simply learning to use SQL or where query

performance or execution are the issues, the kind of data in the database is of little concern. Benchmark databases such as TPC [9] are useful in those situations. Downloading the benchmark database generator written in C/C++ takes almost no time. The generator could install randomly generated databases of various sizes by manipulating the values of some control parameters. On the other hand, in educational programs where the students are more interested in the query results and what they mean, students in a business program for example, it is very difficult to make any real-world sense of the query results from randomly generated databases because these databases contain information that is only marginally realistic. It is nevertheless not reasonable to provide a real database for download, even one of moderate size (a couple of gigabytes) because the download time over the Internet would be unacceptable. The IBM Linux in Academia computing hub provides us with an opportunity to make available to universities a realistic database of considerable size and avoid the typical download time problems. The medical insurance database labelled *insurdb* in Figure 6 plays this role. In order to keep maintenance to a minimum, this install should be read-only.

Although it is possible to allow students to query *insurdb* directly, the result set is usually too large for them to download to their local computers for further analysis using other software packages. In addition, an ill structured query may take hours before a result can be produced. Therefore, we would like to give an instructor control of the size of a customized data warehouse. This project component gives instructors necessary user interface to build their own data warehouses from *insurdb* with the size they deem reasonable for their classes. Since a certain amount of customization would probably be needed we envisage each university/program having its own Linux kernel and own DB2 installed on the same S/390 where the *insurdb* database is installed and that extracts of some size (up to 1 or 2 GBytes) could realistically be made from the *insurdb* database into these user-controlled databases, labelled *WHQuad 1* through *WHQuad n* in Figure 6.

We show how SUNY-NP could use the Linux virtual service environment to support business intelligence course taken by students in our business program and how our own work could be packaged so as to allow other universities to replicate our activities with their own students. We envisage a package that would make it possible for many different users/universities to produce local extracts from the *insurdb* to copies of DB2 running on their own images located on the same S/390 system and into databases we have labelled *WHQuad 1* through *WHQuad n* in Figure 6 using the Account Data Model.

An instructor at university *i* could specify the desired time range, dimensions, and range of attribute values to extract a small portion of *insurdb* and build a customized data warehouse *WHQuad i*. The extract resides in databases controlled by the instruc-

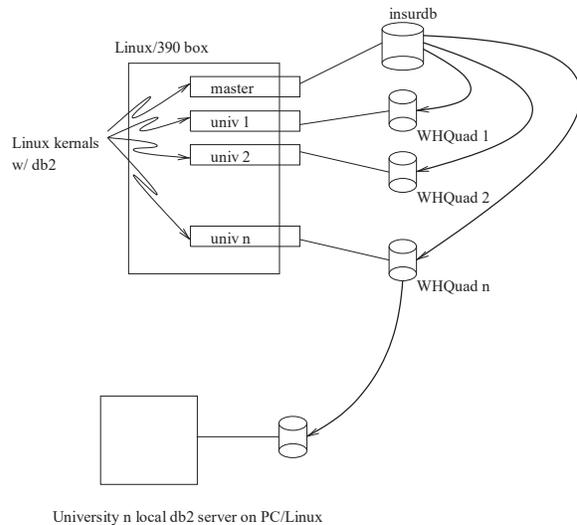


Figure 6: DB2 Structure

tor. In most cases, the instructor may want to make the *WHQuad i* data warehouse read-only to students. The *WHQuad i* databases, although smaller than the *insurdb* database, would still be too large for downloading onto machines that are local to the final users. However they could be used to produce much smaller exports - tables on the order of 2000 to 20000 rows - which would be small enough to download onto local machines (either as files or into a local copy of *db2*) - and it is our intention that these latter tables, looking much like the *fact* tables in a *star-schema* data warehouse but much smaller, could easily be analyzed using local OLAP, Statistics and Data Mining software which, at this time, we do not envisage providing to the user.

Key elements of the package are listed below and explained in Sections 6.1 and 6.2.

- **WHQuad Create :** This script will create the initially empty WHQuad database tables and indices and install various stored procedures and triggers.
- **WHQuad Import :** This program will generate insert statements for the tables in the *WHQuad i* database. The program will proceed from a suitably prepared configuration file and extract data from the *insurdb* database.
- **WHQuad Cube Build :** This program provide the user with a web-based GUI interface from which the user can select *dimensions* and *performance indicators* of interest and build a data cube (typically 2000 to 20000 rows) suitable for analysis using off-the-shelf OLAP tools.
- **WHQuad Export :** This program will export mini-cubes created using the Cube Build software to the user's local copy of *db2*. Although this step is not essential and involves installation and maintenance of a second (local) copy of *db2* by the user,

it will serve as a backup in case the access to the hub server is interrupted.

### 6.1 The WHQuad Databases

We use the Account Data Model (ADM) [7] to build the data warehouse *WHQuad*  $i$ ,  $i = 1, \dots, n$ , due to the fact that ADM is generic and flexible. Once a Linux image and DB2 are available for a university, the *WHQuad Create* program described earlier can be used to install a fresh copy of the *WHQuad* database. This database can be populated with a subset of the information in the *insurdb* database using the *WHQuad Import* program.

A web-based GUI interface, program *WHQuad Cube Build* described in [7], can now be used to extract information from the *WHQuad* tables into mini-cubes or fact tables. A number of OLAP tools such as *Brio* have been developed precisely to present the information in such fact tables.

At this point, the user is able to extract several fact tables containing different dimension/performance indicator configurations. These could be prepared in advance and given to students as source information for data analysis exercises. It is also possible that these *fact tables* could be exported to local copies of DB2 running at the user's university, which we describe next. We should also point out that since *insurdb* adopts a star schema, creating a smaller data warehouse on instructors' images with exactly the same star schema should be straight forward. Thus, we do not include it as a component in this project.

### 6.2 Local Installation of *db2*

We expect the size reduction from



to be in orders of magnitude in general. The *insurdb* database is 57 gigabytes, the *WHQuad* databases as large as a couple of gigabytes but usually smaller than 2 gigabytes and the *fact tables* generated by the *WHQuad Cube Build* software could be as big as 2 megabytes.

Only the latter tables are small enough to be realistically downloaded to machines local to the participating universities. They are just on the edge of being too large to be used on an *ad hoc* basis so we feel the appropriate thing to do is to download them once and use the local copy for conducting classroom activity when the connection to the Linux image is either interrupted or unbearably slow. The program *WHQuad Export* would accomplish this task. It is also possible to use IBM data migration software to do this.

## 7 Other Components of the Project

Next to the applications surrounding DB2 databases is the development of WebSphere applications. There

are several application areas that WebSphere can play a major role.

1. As mentioned earlier, all tools developed for an instructor to generate a data warehouse from the medical insurance database are web based applications. Java Servlets provides a good tool for database intensive applications.
2. The target users of this service are business students who usually do not have profound knowledge in Linux operating system and programming. In order to shield the technical details from the students, a web interface supported by WebSphere as the middleware allows students to focus on analytical and business issues rather than struggling with programming details.
3. We would also like to create some templates for student to easily deploy a virtual company with online transaction capability. This will first link to the database created by students to operate their e-store. Step by step, it can be developed into an online trading community where there are buyers, sellers and transaction facilitating media such as banks and shippers.

The third component in this project covers the area of group decision support, which is a key element in knowledge management. An open source, XML-based software, Jabber [3], can be used as a building block for creating and testing a group decision support environment. Other miscellaneous supporting tasks like developing tools to assist instructors managing student accounts are also intended. This includes programs for setting up the accounts, granting appropriate privileges, and monitoring usage.

## 8 Conclusion

In this paper, we introduce the service offered by the IBM Linux in Academia program and describe a project designed to take advantages of the service provided by the program. The objective of the project is to develop instructional resources including a data warehouse generator using a web based user interface and the Account Data Model. The software allows instructors to carve out a portion of a huge database and create a customized data warehouse for their instructional needs. The data warehouse generator along with other web based resources are designed to facilitate the offering of e-Business and knowledge management related courses in a business program. We hope the software and tools produced from this project can help a business program enhance its capacity and capability to train students on both strategic and analytical issues related to e-Business and knowledge management. We would also like to invite participation from other institutions to contribute to the process of developing and testing more instructional resources.

## References

- [1] Chen, P. P., “The Entity-Relationship Model: toward a Unified view of data”, *ACM Trans. on Database Systems*, Vol. 1, 1, 1976, 9-36.
- [2] CSU/IBM Linux Hub Home Page, <http://204.146.24.13>
- [3] Jabber Software Foundation, <http://www.jabber.org>
- [4] Kaplan, Robert S., Norton, David P., *The Balanced Scorecard - Translating strategy into Action*, Harvard Business School Press, Boston, 1996.
- [5] Kimball, Ralph, A Dimensional Modeling Manifesto, *DBMS*, vol. 10, no. 9, 1997, pp. 58-72.
- [6] Olavsrud, Thor, “IBM Offers Processing Power As Utility”, *InternetNews*, July 1, 2002.
- [7] Pletch, A., Tsai, C-Y., and Matula, C., “The Account Data Model”, in S. Spaccapietra, S.T. March, Y. Kambayashi, (Eds) *Lecture Notes in Computer Science for the 21st International Conference on Conceptual Modeling (ER2002)*, October 7-11, 2002, Tampere, Finland, Vol 2503, pp. 263-275.
- [8] Todman, Chris, *Desiging a Data Warehouse—Supporting Customer Relationship Management*, Prentice Hall PTR, New Jersey, 2001.
- [9] Transaction Processing Performance Council, <http://www.tpc.org>.

# Moderators in the Adoption of E-Learning: An Investigation of the Role of Gender

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## Abstract

Past research has hypothesized and empirically supported a model for learners' acceptance of e-learning. To further investigate the influence of gender on e-learning acceptance, data were collected from a sample of 259 Taiwanese undergraduates that were relatively balanced between genders. Comparisons of means and multiple-group Structural Equation Modeling (SEM) with LISREL were used to analyze the data.

Examining *t*-test results indicated that differences in construct means between males and females occurred only for some of the model predictors. Specifically, men have more confidence in using the technology, more Internet experience, a higher perception of system interactivity, and higher beliefs of usefulness and ease of use than women. However there is no significant difference in their intentions to use the e-learning system. In addition, multiple-group SEMs revealed that gender moderated some of the relationships between the hypothesized determinants and intentions to use the e-learning system. In particular, women's adoption intention for distance education purposes is more strongly influenced by system interactivity. Women's perception of e-learning usefulness is negatively influenced by self-efficacy. Some implications for practical purposes are addressed.

## 1. Introduction

E-learning has become an information system market full of growth potential with the computer and Internet steadily gaining popularity [1] [32]. The phenomenon seems to have gone in the direction as Peter Drucker, a noted management professor, has pointed out that the biggest impact of Information Technology (IT) would be on knowledge industries such as education and medicine that were in great need of increased productivity [6]. Corporate training, universities, government, and K-12 education have become four important market segments for e-learning.

An e-learning system is an integrated system as opposed to stand-alone, single-function systems. Recently, more advanced e-learning systems, such as WebCT (<http://www.webct.com>) and Cyber University of NSYSU (<http://cu.nsysu.edu.tw>) have been developed. These systems are specifically designed for teaching and learning purposes and can be used to integrate course development

tools, course material (audio, video, and text), e-mail, live chat sessions, online discussions, and the World Wide Web. With this kind of system, instructional delivery and communication between instructors and students can be conducted either synchronously or asynchronously.

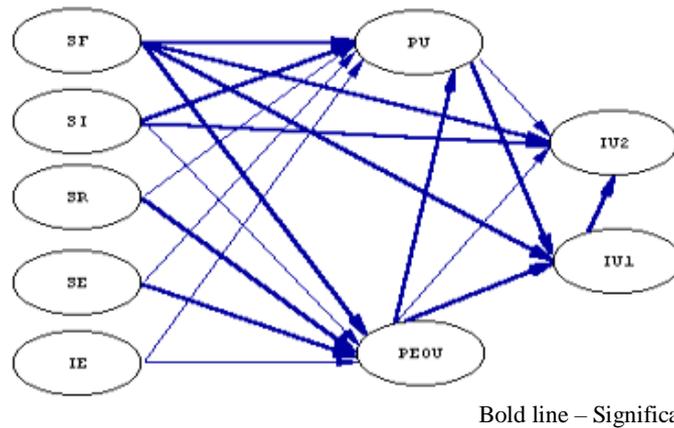
According to the Digest of Education Statistics 2000 [25], between 1988 and 1998, the enrollment growth of key demographic groups has been changing. During that ten-year period, the enrollment in degree-granting institutions for females (16%) was higher than for males (6%). This difference was especially noticeable at the graduate level, as the number of female full-time graduate students increased 60% as opposed to a 17% increase for males. A similar increase of female students has taken place in Taiwan between 1986 and 1999, according to the Ministry of Education [23]. In the adoption of innovation (in this case, e-learning), the factors predicting e-learning adoption may vary across demographic groups. The purpose of this study then is to investigate how gender will influence the acceptance of an e-learning system. In particular, the following research questions guided the study:

1. Do male and female learners have similar perceptions and use intentions regarding e-learning acceptance?
2. Do the relationships between learners' behavioral intentions to use an e-learning system and determinant factors differ for male and female learners?

## 2. Literature Review

### 2.1 Research Model

Lee and Pituch [21] proposed and empirically supported an e-learning acceptance model as shown in Figure 1. The model is derived from the Technology Acceptance Model [10] and Diffusion of Innovation (DOI) perspective [27]. This model uses behavioral intention as a surrogate for IT acceptance of novice learners. The acceptance criteria were categorized into behavioral intentions to use the e-learning system as a supplementary learning tool (IU1) and as a distance education method (IU2). Lee and Pituch found that factors related to IT acceptance included perceived usefulness (PU), perceived ease of use (PEOU), system characteristics (functionality, interactivity, and response), and learner characteristics (self-efficacy and Internet experience). In this study, as well as that of Lee and Pituch, behavioral intention is



**Figure 1. E-learning acceptance model (Lee & Pituch [21])**

interpreted as the strength of one's intention to use an e-learning system either as a supplementary tool for a face-to-face class or as an entire on-line distance education method. Based upon Davis et al. [10], perceived usefulness is interpreted as the prospective learner's subjective probability that using an e-learning system will increase his or her learning performance. Perceived ease of use is interpreted as the degree to which the prospective learner expects the e-learning system to be free of effort.

In addition, Lee and Pituch [21] hypothesized that e-learning acceptance was related to three system factors and two learner characteristics. The system characteristics are defined as follows. System functionality (SF) is a learner's opinion or perception of system functions related to learning and relative advantage as to time and place in learning. Relative advantage, according to Rogers [27, p.212], is "the degree to which an innovation is perceived as being better than the idea it supersedes." System interactivity (SI) is a learner's opinion or perception of the e-learning system's ability in enabling interactions between teacher and students, and among students themselves. System response (SR) is the degree to which a learner perceives whether the system response is fast/slow, consistent, and reasonable in requesting a system service [2]. For the learner characteristics, self-efficacy (SE), based on [7], is defined as one's self-confidence in his or her ability to perform certain learning tasks using an e-learning system. Internet experience (IE) is the extent to which a prospective learner uses the Internet [28].

## 2.2 The Role of Gender

Associations between gender and technology have been reported. An early example of gender differences in technology adoption was telephone use, where women's use of the telephone for socialization purposes helped expand this usage in both residential and business areas [22]. Hopkins [18, p.3] encouraged others to study gender differences, stating, "A significant part of the study of technology and gender is the study of how new technologies are evaluated through the lens of an existing gender system."

Gender differences have also been found with other technology adoption. For example, "computational reticence" [33, p.365] is the resistance to become emotionally and socially involved with computers. It explained women's initially less frequent use of computers. In addition, men and women tend to view the world differently. Men tend to see the real world as a hierarchical structure whereas women tend to view it as an interconnected web of people [16]. From this perspective, computer and communication technology might affect men and women differently because of the different communication patterns adopted. Also, gender is one of the physiological factors influencing knowledge acquisition. For example, men are inclined to be competitive and aggressive and may respond better to competitive games [17]. In addition, a study of knowledge workers in the airline industry found that women and men differed in their beliefs of usefulness and ease of use but not actual use of e-mail [13]. That study also suggested that researchers should include gender in IT adoption models. Another study investigating gender differences in adopting new software systems found that men's technology acceptance was more strongly affected by their perception of usefulness, while women were more strongly influenced by perceptions of ease of use and subjective norms [34].

The e-learning acceptance model (as shown in Figure 1) has been validated in prior research. It provides a sound framework for further exploration of gender differences in technology adoption. In addition, reviewing the literature suggests that construct means and some of the relationships in the model may vary for males and females. Therefore, the focus of the research is on exploring how these groups may differ regarding e-learning acceptance and its determinants.

## 3. Methodology

For this study, data collected from previous research [21] were examined for gender differences. In brief, participants in the study consisted of postsecondary students enrolled in computer classes at a college in

Taiwan. Students were given a 40-minute live demonstration of an e-learning system and 30 minutes to individually practice with it. The e-learning system used is the Cyber University at National Sun Yat-Sen University, Taiwan. It provides Internet users with a guest account. A total of 259 surveys were collected from participants in the demonstration and practice phases. Respondents were relatively balanced between sexes (male 41.7%, female 58.3%) and educational divisions (traditional students 55.2%, non-traditional students 44.8%). The survey instrument that was used in [21] is shown in Appendix 1. Seven-point Likert-type scales were used to measure learners' agreement/ disagreement level for usefulness, ease of use, behavioral intentions, system functionality, system interactivity, and system response. The same scales were used to measure learners' confidence in using the technology as well as the extent to which learners had previously used the Internet. Learners' demographic data were also collected. To address research question 1, separate *t*-tests were used to examine gender differences in the composite means of all nine factors. For research question 2, multi-group Structural Equation Modeling (SEM) [4] [20] [31] with LISREL 8.50 was used to identify the moderating effects of gender on the research model (as shown in Figure 1).

A multi-group SEM is "an SEM extension that permits the comparison of models over multiple populations or groups" [31, p.219]. The main focus of a multi-group analysis is to identify differences in path coefficients between groups [20]. Prior to testing a multi-group path model, researchers typically test the equality of factor structures of the measurement model across groups [19]. In this study, such a factor-loading invariance model was tested by examining the difference in model fit as reflected by chi-square statistics for two opposing confirmatory factor analysis (CFA) models: one with the factor loadings constrained to be the same across groups and the other without such constraints. Second, a test of invariance of the model paths was conducted by constraining the paths to be the same across both groups [4] [20]. Model fit indices were examined. In addition, modification indices were also examined to determine which path, if estimated separately for each group, would result in a significant chi-square decrease reflecting an improvement in model fit. Models were re-specified accordingly and tested. The procedure continued until there were no more modification indices indicating possible improvement in model fit. Covariance matrices for both male and female groups were used as input data for the multi-group SEM. For sample size considerations, researchers using the SEM approach have recommended various minimum sample sizes. A minimum of 100 has been suggested [3]. In addition, the average sample size for MIS studies using LISREL was 249 (minimum 41, maximum 451) [15]. Therefore, the sample size of 108 men and 151 women in this study was considered adequate.

#### 4. Research Findings

As shown in Table 1, male learners had higher mean scores than female learners for each of the nine constructs associated with learners' behavioral intentions to use e-learning. Using an alpha level of .05, significant differences favoring males were found for the constructs perceived usefulness, perceived ease of use, system interactivity, self-efficacy, and Internet experience. With the Bonferroni approach, where .05 was divided by the number of tests (9) or .006, to adjust the significance level to minimize the chances of making a Type I error, male learners had significantly higher means in perceived usefulness, perceived ease of use, self-efficacy, and Internet experience than female learners.

**Table 1. Differences in factor means based on gender**

Factors	Male		Female		<i>t</i> value	Prob.
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>		
PU	5.14	1.03	4.78	0.91	2.996	.003**
PEOU	5.31	1.11	4.86	1.00	3.399	.001**
IU1	5.27	1.24	5.00	1.04	1.874	.062
IU2	5.30	1.22	5.13	1.20	1.095	.275
SF	5.72	1.07	5.69	0.95	0.239	.812
SI	5.06	1.17	4.73	1.06	2.362	.019*
SR	4.89	1.09	4.73	0.92	1.303	.194
SE	5.01	1.21	4.49	1.07	3.666	.000**
IE	5.39	1.32	4.90	1.21	3.087	.002**

Note. *N* = 108 for male, 151 for female, *df* = 257 for each factor.  
\* *p* < .05. \*\* *p* < .006 using Bonferroni approach.

A multi-group SEM was conducted to compare the structural equation model over male and female learners. The purpose of this analysis was to identify if gender moderated any of the relationships in the model used to predict learners' behavioral intentions to use e-learning. Prior to testing the differences in path estimates between males and females, measurement models were tested for each group separately. Table 2 shows that the measurement models (single group CFA) for both females and males had adequate model fit. In addition, examining the difference in fit between a baseline model that allowed all factor loadings to vary across the two groups and a factor loading invariance model that constrained the factor loadings to be the same for males and females provides support for the more restrictive model. As presented in Table 2, the difference in the fit of these models is not statistically significant,  $\chi^2_{\text{difference}}(41, N = 259) = 54.29, p > .05$ . In addition, since the overall fit indicators provide support for the invariant factor loading model, this measurement model was used to test the difference in the relationships among constructs for males and females.

Following the establishment of a common measurement model, a series of multi-group SEMs were performed. As suggested by [4] [20], the first model specified that the structural paths, reflecting the relationships among the constructs, were the same for males and females. The analysis of this model indicated an acceptable model fit,  $\chi^2/df = 1.43, CFI = .957, NNFI = .951$ . However, the modification indices indicated that the chi-square would decrease 3.88 if the path from SE to

**Table 2. Test results of multi-group SEMs based on gender**

Model	<i>N</i>	$\chi^2$	<i>df</i>	$\chi^2/df$	$\chi^2_{diff}$	<i>df</i> <sub>diff</sub>	CFI	NNFI
				< 3.0 <sup>a</sup>			> .90 <sup>a</sup>	> .90 <sup>a</sup>
Single Group CFA								
Female	151	311.13*	216	1.44			0.962	0.952
Male	108	316.76*	216	1.47			0.956	0.944
Multiple Group CFA								
Baseline (no constraints)	259	627.89*	432	1.45			0.959	0.948
Factor Loading Invariance	259	652.58*	473	1.44	54.29	41	0.957	0.949
Multiple Group SEM Models								
1. Paths Invariance	259	687.67*	480	1.43			0.957	0.951
2. Free SE->PU	259	683.72*	479	1.43	3.95*	1	0.958	0.951
3. Free SI->IU2	259	679.74*	478	1.42	3.98*	1	0.958	0.952

<sup>a</sup> Recommended values. \* *p* < .05.

PU were estimated separately for each group. A model allowing for this relationship to differ across groups was then specified accordingly and tested. The fit of this model was acceptable,  $\chi^2/df = 1.43$ , CFI = .958, NNFI = .951, and had better fit than the initial model,  $\chi^2_{difference} (1, N = 259) = 3.95$ , *p* < .05. The modification indices for this second model also suggested that the chi-square would decrease 3.90 if the path from SI to IU2 were estimated separately for each group. This third model was specified accordingly and tested. The fit of this model was also acceptable,  $\chi^2/df = 1.42$ , CFI = .958, NNFI = .952, and had better fit than the second model,  $\chi^2_{difference} (1, N = 259) = 3.98$ , *p* < .05. For this third model, a modification index of 4.94 was obtained for freeing the estimation of the path from IU2 to IU1. Since the link was not in the hypothesized model, it was not considered. No other modification indices (the largest was 3.246) indicated that any further improvement in model fit could be achieved by freeing estimation of other paths.

The moderating effects of gender on the relationships in the path model are presented in Table 3. The standardized direct effects found to be the same across gender groups are shown in the common metric column. The values shown in the female and male columns are the standardized path coefficients estimated separately for each group. In particular, system interactivity influenced behavioral intention to use the IT as a distance education method for females (0.213, significant) but not for males (0.042, insignificant). Self-efficacy negatively influenced the perception of usefulness for females (-0.199,

significant) but not for males (0.013, insignificant). The results of multi-group SEMs for gender are illustrated in Figure 2.

## 5. Discussion

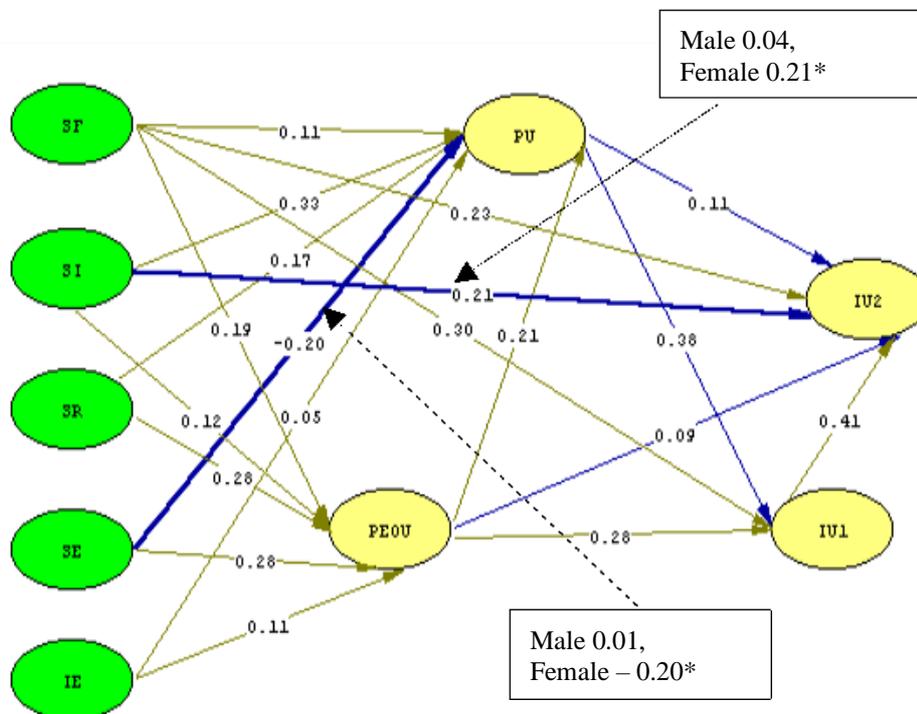
The results of this study indicated that, with regard to e-learning, male learners had more confidence in using the technology, more Internet experience, a higher perception of system interactivity, and higher beliefs of technology usefulness and ease of use. These results are consistent with prior studies [8] [24] [26] [35]. For example, males were found to have significantly higher computer self-efficacy [24]. Females, on the other hand, were found to have significantly less positive attitudes/opinions towards computing than males [8] [26] [35]. In a recent study investigating gender differences in individual adoption of technology, the respective composite means of perceived usefulness, perceived ease of use, and behavioral intention for men were all higher than women's at three different stages (post training, after one month, and after three months), although the difference of perceived usefulness in the post training stage was insignificant [34]. The results of this study as presented in Figure 3 are in accord with those prior studies. Yet one prior research investigating gender differences in e-mail use presented mixed results: men had a significantly higher perception of ease of use than women, but had an opposite results for perceived usefulness [13].

Examining the differences in construct means through

**Table 3. The moderating effects of gender on the research model**

Outcome	Determinant	Standardized Direct Effects		
		Metric	Female	Male
Perceived Ease of Use	System Functionality	0.187*		
	System Interactivity	0.125		
	System Response	0.276*		
	Self-efficacy	0.277*		
	Internet Experience	0.110		
Perceived Usefulness	Perceived Ease of Use	0.215*		
	System Functionality	0.114*		
	System Interactivity	0.334*		
	System Response	0.171		
	Self-efficacy		-0.199*	0.013
	Internet Experience	0.086		
Intention to Use 1 (Supplementary tool)	Perceived Usefulness	0.379*		
	Perceived Ease of Use	0.276*		
	System Functionality	0.304*		
Intention to Use 2 (Distance Education)	Intention to Use 1	0.405*		
	Perceived Usefulness	0.110		
	Perceived Ease of Use	0.090		
	System Functionality	0.234*		
	System Interactivity		0.213*	0.042

Note. N = 259. \* p < .05.



**Figure 2. Multi-group SEM results for male and female learners**

the path model of this study (SE -> PEOU -> PU -> IU1 -> IU2) indicated that gender differences were large for self-efficacy but decreased on the path to IU2 as shown in Figure 3. The p-value for the t-test of these mean differences increased from less than .001 (significant) to a .275 (insignificant). These results are consistent with the finding that gender differences occur in the “the initial expectations for performance” [12, p.106] [13].

In addition, gender showed a moderating effect on some of the relationships in the path model. The relationships in the path model were the same for both female and male learners except for two paths. First, the direct effect of system interactivity on intention to use IT for distance education was present for females but not for males. In other words, system interactivity was more important to female than male learners in determining intention to use the IT for distance education. Considering the many-to-many communications provided by the Web-based learning technology, it enables the networking approach of communication pattern apparently preferred by female learners and, therefore, seems to be more important for females than males. This finding is consistent with the notion as stated by [13] that women tend to adopt a networking approach, using discourse to achieve intimacy, support, consensus, and rapport [30], whereas men tend to adopt a communication pattern based on social hierarchy [29]. These two communication patterns appear to have different implications to learners’ intentions to use the e-learning system.

Second, self-efficacy significantly impacted perceived usefulness for females in a negative direction. This suggests that females with more confidence in using the technology have weaker beliefs in the technology’s usefulness. One possible explanation for this counterintuitive finding is that female learners who have relatively lower initial confidence in using a new technology may be overwhelmed after a brief exposure to the technology and, as a result, may have overly high expectations of its usefulness. On the other hand, females

having a higher confidence level may perceive that the system is not that useful. This phenomenon needs to be further investigated.

In addition, study results indicated that the relationship between perceived usefulness and behavioral intentions were the same for men and women, and the relationship between perceived ease of use and behavioral intentions also did not differ for men and women. Therefore, the findings [34] that men’s adoption decisions were more strongly influenced by their perceptions of usefulness, and women’s were more strongly influenced by perceptions of ease of use, were not supported.

## 6. Conclusions

Theoretically, this study further identifies some of the differences in the perceptions of technology acceptance and differences in the relationships between predictors of this acceptance for males and females. Although male learners have significantly more confidence in using the technology, more Internet experience, a higher perception of system interactivity, and higher beliefs of usefulness and ease of use than female learners, there is no significant difference in their intentions to use the e-learning system. In addition, gender has moderating effects on the relationships between the hypothesized determinants and intentions to use the e-learning system. In particular, women’s adoption intention for distance education purposes is more strongly influenced by system interactivity. Women’ perception of e-learning usefulness is negatively influenced by self-efficacy.

For practical purposes, the results of this study may be beneficial to educators and corporate trainers. The findings in this study suggest that specific factors may be targeted to enhance IT use among the groups. For example, special emphasis can be placed on improving system interactivity in order to elevate female learners’ intention to use the e-learning system for distance education.

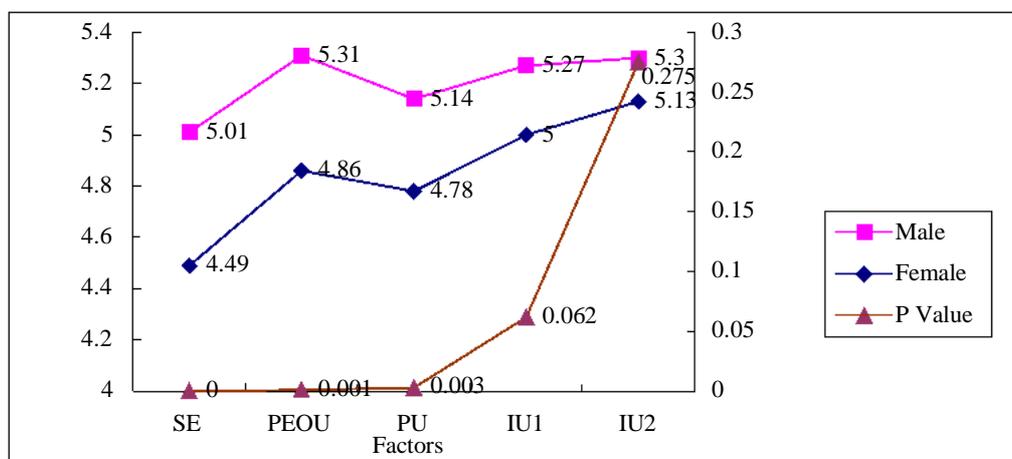


Figure 3. Gender differences on factor means

## 7. Appendices

### Appendix 1: Operationalization of Constructs

Constructs	Questions	References
Perceived Usefulness (PU)	Using the Web-based learning system will allow me to accomplish learning tasks more quickly. Using the Web-based learning system will improve my learning performance. Using the Web-based learning system will make it easier to learn course contents. Using the Web-based learning system will increase my learning productivity. Using the Web-based learning system will enhance my effectiveness in learning.	[9][14]
Perceived Ease of Use (PEOU)	Learning to operate the Web-based learning system is easy for me. It is easy for me to become skillful at using the Web-based learning system. I find the Web-based learning system easy to use.	[9][14]
Intention to Use (IU1)	<b>The Web-based learning system as a supplementary course tool:</b> I will always try to use the Web-based learning system to do a learning task whenever it has a feature to help me perform it. I will always try to use the Web-based learning system in as many cases/occasions as possible.	[5][11]
(IU2)	<b>The Web-based learning system as an entire distance education method:</b> I intend to take this course and always try to use the Web-based learning system to do a learning task whenever it has a feature to help me perform it. I plan to take this course and always try to use the Web-based learning system in as many cases/occasions as possible.	
System Functionality (SF)	The Web-based learning system offers flexibility in learning as to time and place. The Web-based learning system offers multimedia (audio, video, and text) types of course contents.	
System Interactivity (SI)	The Web-based learning system enables interactive communications between instructor and students. The Web-based learning system enables interactive communications among students.	
System Response (SR)	When you are using the Web-based learning system, system response is fast. In general, the response time of the Web-based learning system is consistent. In general, the response time of the Web-based learning system is reasonable.	[2]
Self Efficacy (SE)	<b>I am confident of using the Web-based learning system ...</b> Even if there is no one around to show me how to do it. Even if I have only the online instructions for reference.	[7][28]
Internet Experience (IE)	<b>Please indicate the extent to which you use the Internet to perform the following tasks:</b> Gathering information Communication (e.g. email, chat) Downloading free software	[28]

## References

[1] Anderson, C., Dankens, A., & Julian, E. H. "Worldwide and U. S. corporate IT education and training services: forecast and analysis 1999-2004 (International Data Corporation Report No. W22154)," 2000, Abstract retrieved October 30, 2001, from <http://www.itresearch.com/alfatst4.nsf/UNITABSX/W22154?OpenDocument>.

[2] Bailey, J. E., & Pearson, S. W. "Development of a tool for measuring and analyzing computer user satisfaction," *Management Science*, 1983,29(5), 530-545.

[3] Bollen, K. A. *Structural equations with latent variables*, New York, NY: Wiley-Interscience, 1989.

[4] Byrne, B. M. *Structural equations modeling with LISREL, PRELIS, and SIMPLIS: Basic concepts, applications, and*

- programming. Mahwah, New Jersey: Lawrence B. M. Erlbaum Associates, 1998.
- [5] Chau, P. Y. K. "An empirical assessment of a modified technology acceptance model," *Journal of Management Information Systems*, 1996,13(2), 185-204.
- [6] CIO Magazine. "A meeting of the mind," from [http://www.cio.com/archive/091597\\_interview\\_content.html](http://www.cio.com/archive/091597_interview_content.html).
- [7] Compeau, D. R., & Higgins, C. A. "Computer self-efficacy: Development of a measure and initial test," *MIS Quarterly*, 1995,19(1), 189-211.
- [8] Dambrot, F., Watkins-Malek, M., Silling, S., Marshall, R., & Gordon, J. "Correlates of sex differences in attitudes towards and involvement with computers," *Journal of Vocational Behavior*, 1985,27(1), 71-86.
- [9] Davis, F. D. "Perceived usefulness, perceived ease of use and user acceptance of information technology," *MIS Quarterly*, 1989,13(3), 319-339.
- [10] Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. "User acceptance of computer technology: A comparison of two theoretical models," *Management Science*, 1989,35(8), 982-1003.
- [11] Davis, F. D., & Venkatesh, V. "A critical assessment of potential measurement biases in the technological acceptance model: Three experiments," *International Journal of Human-Computer Studies*, 1996,45, 19-45.
- [12] Deaux, K. "From individual differences to social categories: Analysis of a decade's research on gender," *American Psychologist*, 1984,39(2), 105-116.
- [13] Gefen, D., & Straub D. W. "Gender differences in the perception and use of e-mail: An extension to the technology acceptance model," *MIS Quarterly*, 1997,21(4), 389-401.
- [14] Gefen, D., & Straub D. W. "The relative importance of perceived ease of use in IS adoption: A study of E-Commerce adoption," *Journal of the Association for Information System*, 2000,1(8), Retrieved March 10, 2001, from <http://jais.aisnet.org/articles/default.asp?vol=1&art=8>.
- [15] Gefen, D., Straub. D. W., & Boudreau, M. "Structural equation modeling and regression: Guidelines for research practice," *Communications of the Association for Information Systems*, 2000,4(7), Retrieved March 10, 2001, from <http://cais.aisnet.org/articles/default.asp?vol=4&art=7>.
- [16] Gilligan, C. *In a Different Voice: Psychological Theory and Women's Development*, Cambridge: Harvard University Press, 1982.
- [17] Heinich, R., Molenda, M., Russell, J. D., & Smaldino, S. E. *Instructional media and technologies for learning (5th ed.)*, Englewood Cliffs, NJ: Prentice-Hall, 1996.
- [18] Hopkins, P. D. *Sex/machine: Readings in culture, gender, and technology*, Bloomington, Indiana: Indiana University Press, 1998.
- [19] Joreskog, K. G., & Sorbom, D. *LISREL 8: Structural equation modeling with the SIMPLIS command language*, Hillsdale, NJ: Erlbaum, 1993.
- [20] Kline, R. B. *Principles and practice of structural equation modeling*, New York, NY: The Guilford Press, 1998.
- [21] Lee, Y., & Pituch, K. "Modelling the acceptance of information technology that enables a paradigm shift: A study of e-learning adoption," *Proceedings of the Fifth Annual Conference of Southern Association for Information Systems*, Georgia, USA, 2002, 152-161.
- [22] Martin, M. "The culture of the telephone," In Hopkins, P.D. (Eds.), *Sex/machine: Readings in culture, gender, and technology* (pp. 50-74), Bloomington, Indiana: Indiana University Press, 1991.
- [23] Ministry of Education. "Summary of Statistics," 2002, Retrieved March 01, 2002, from <http://www.edu.tw/english/index.htm/>
- [24] Miura, I. T. "Processes contributing to industrial differences in computer literacy," Unpublished doctoral dissertation, College of Business, Stanford University, San Francisco, CA, 1984.
- [25] National Center for Education Statistics. "Digest of Education Statistics (NCES 2001034)," 2000, Retrieved March 20, 2001, from <http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2001034>
- [26] Parasuraman, S., & Igarria, M. "An examination of gender differences in the determinants of computer anxiety and attitudes towards microcomputers among managers," *International Journal of Man-Machine Studies*, 1990,32, 327-340.
- [27] Rogers, E. M. *Diffusion of Innovations (4th ed.)*, Free Press, New York, NY, 1995.
- [28] Tan, M., & Teo, T. S. H. "Factors influencing the adoption of Internet banking," *Journal of the Association for Information System*, 2000,1(5), Retrieved March 10, 2001, from <http://jais.aisnet.org/articles/default.asp?vol=1&art=5>.
- [29] Tannen, D. *You just don't understand: Women and men in conversation*, New York, NY: Ballantine, 1990.
- [30] Tannen, D. *Gender and discourse*, New York, NY: Oxford University Press, 1994.
- [31] Tate, R. *An introduction to modeling outcomes in the behavioral and social sciences (2th ed.)*, Edina, MN: Burgess, 1998.
- [32] The Campus Computing Project. "The 2000 national survey of information technology in US higher education," Retrieved January 31, 2001, from <http://www.campuscomputing.net>.
- [33] Turkle, S. "Computational reticence: Why women fear the intimate machine," In Hopkins, P.D. (Eds.), *Sex/machine: Readings in culture, gender, and technology* (pp. 365-380). Bloomington, Indiana: Indiana University Press, 1988.
- [34] Venkatesh, V., & Morris, M. "Why don't men ever stop to ask for directions? Gender, social influence, and their role in technology acceptance and usage behavior," *MIS Quarterly*, 2000,24(1), 115-139.
- [35] Wilder, G., Mackie, D., & Cooper, J. "Gender and computers: Two surveys of computer-related attitudes," *Sex Roles*, 1985,13(3-4), 215-228.

# The E-Commerce Application Experience in Selected Asian MBA Programmes

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## Abstracts

The objectives of the paper are: (1) to analyse the effects of changing towards a knowledge economy and the development of MBA programmes in selected Asian countries, including Singapore, Malaysia, Hong Kong, China and Taiwan, China; (2) to study how e-commerce applications can be applied to MBA programme studies; (3) to find out what kinds of competitiveness are derived from MBA education with e-commerce facilities; and (4) to conclude lessons learnt from applying e-commerce technology into MBA programmes.

A stakeholders approach has been used to conduct a primary research and a secondary research during the period between April and May 2002. 107 were interviewed, and 174 questionnaires returned.

E-commerce technology has positively affected the rapid growth of MBA programmes, particularly distance learning and online programmes. An e-commerce education model can help to better understand how we can utilize the concepts of supply chain and e-commerce technology in MBA programmes. The supply chain of distance learning and online MBA programmes rely heavily on e-commerce technology. In full-time, part-time, and distance learning MBA programmes, teachers required students to access information from the Internet. Many MBA courses must have university technical support to be successful.

Globalisation of MBA programmes cannot be successful without e-commerce technology. This globalisation knowledge will give MBA graduates a competitive advantage after graduation. In the design of MBA curriculum, teachers must have some knowledge about the technical aspects of e-commerce. In MBA education, speed of information is crucial to students and teachers, and will change their needs and wants.

Online distance learning MBA programme is still unpopular. The combination mode of teaching is dominating the trend in distance learning MBA education. Government regulations on e-commerce can affect information flow, and adversely affect the development of MBA programmes. Security of information is always a concern of the users.

## 1. Introduction

### 1.1 MBA education

The knowledge economy trend worldwide has increased the importance of MBA education where the

practical general management education can adapt more to the real world situation through continuous e-commerce applications. About five years ago, some universities offered more specialised MBA programmes; e.g. The Curtin University of Technology in Australia. However, most leading business schools still only offer the general MBA programme. The Stanford MBA Program is a general management degree. Because of that, you will not be required to specialized in one area, such as finance or marketing, but rather you'll build a program that suits your professional and personal goals.<sup>1</sup>

### 1.2 MBA courses increased globalisation trend

Many business schools recognize the growing importance of globalisation, and pioneer into providing MBA courses that relate to it, e.g. INSEAD. The principal objective of the INSEAD MBA is to provide a solid foundation for your future in general management in a constantly changing global business environment.<sup>2</sup>

To achieve the globalisation objective, some MBA programmes require students to take e-commerce related courses to their core subjects. Tuck School of Business is a good example. Others will encourage students to take international or global related courses that will eventually become a certificate. In the Berkeley MBA programme, students can earn a "Certificate in Global Management". Requirements for the certificate fall into three areas: overseas experience, courses with international content, and language requirement.<sup>3</sup>

### 1.3 MBA education as a tool to build personal competitive advantage

In the past 20 years, there was a clear shift from an industrial organization economics structure conduct performance paradigm to a competence-based competition.<sup>4</sup> Many MBA programmes' designs have shifted to teach courses that relate to generate or improve the competitive advantages of the MBA students. Examples include e-commerce specialization courses,

<sup>1</sup> Stanford MBA brochure, 2002, p3.

<sup>2</sup> INSEAD MBA brochure, 2002, p4.

<sup>3</sup> The Berkeley MBA, Full-Time MBA Program 2002.

<sup>4</sup> Howard Thomas and Timothy Pollock, From I-O Economics' S-C-P Paradigm Through Strategic Groups to Competence-Based Competition: Reflections on the Puzzle of competitive Strategy, British Journal of Management, 1999, Vol. 10, pp127-140.

global concentrations and entrepreneurial electives. In selecting an MBA programme, many potential MBA students actually place great emphasis on what kinds of competitive edge they can derive after graduation.

## 2. The Study Objectives of the Research Paper

### 2.1 Background

In the past 20 years, there were many MBA programmes in various Asian countries, e.g. in Hong Kong, China, Singapore, and Thailand. Most model the American or English MBA programmes, whether full-time, part-time, or distance learning. These MBA programmes help to train international executives with a globalised view and with good personal competitive advantages. There is a need to understand more about various MBA programmes in Asia. Researches into Asian MBA programmes are limited; and Asian regional comparisons, extremely limited.

### 2.2 The objectives

The objectives of the research paper are:-

- (1) to analyse the effects of changing towards a knowledge economy and the development of MBA programmes in selected Asian countries, including Singapore; Malaysia; Hong Kong, China; and Taiwan, China;
- (2) to study how e-commerce applications can be applied to MBA programme studies;
- (3) to find out what kinds of competitiveness are derived from MBA education with e-commerce facilities; and
- (4) to conclude lessons learnt from applying e-commerce technology into MBA programmes and to look ahead challenges facing MBA business schools in the immediate future.

### 2.3 The Approach

To ensure a complete view about the study, a stakeholder analysis will be used. Interest parties related to MBA programmes will be studied.

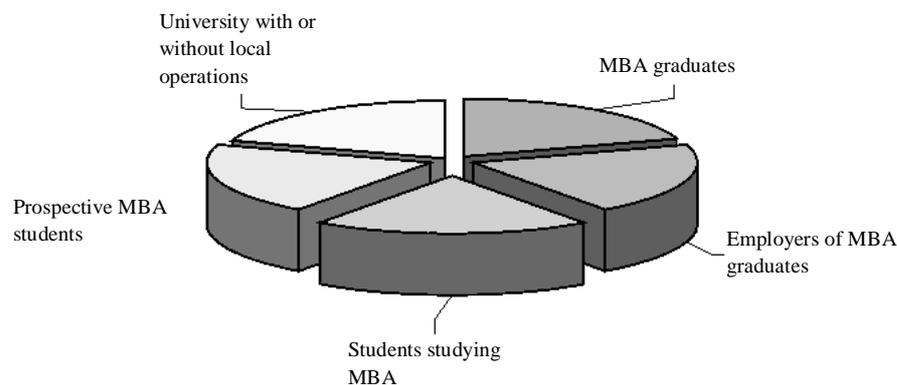


Figure 1: Stakeholder analysis of MBA programmes

The study was conducted in two parts, namely primary and secondary researches during the period between April and May 2002. The data of the primary research was obtained through interviews and returned questionnaires from various MBA stakeholders including university MBA teachers/administrators, local or regional MBA operators, students studying MBA, prospective MBA students, MBA graduates and MBA employers. 107 were interviewed, and 174 questionnaires returned. The secondary research data was collated from various university's MBA brochures, catalogues, facilities, and local and international advertisements.

### 2.4 The limitations

MBA education research is a big research area. Due to limitation in time and personnel, only a very small part of the area is being studied. The findings might not be fully representative of the actual situation. However, it was an introduction into the subject matter. A summary of the responses was outlined below.

	Interviewed	Target	Actual	% Target
1	University offering MBA programmes - Teaching staff	15	12	80%
2	Operators of distance learning MBA programmes - Owners/senior staff of local/regional operators - Administrative staff of local/regional operator	5 5	4 4	80% 80%
3	MBA students - Full-time/part-time - Distance learning	30 20	27 18	90% 90%
4	MBA graduates - Full-time/part-time - Distance learning	20 10	14 7	70% 70%
5	Potential MBA students - Full-time/part-time - Distance learning	10 10	7 8	70% 80%
6	External stakeholders - Employers of MBA students	10	6	60%
	Total	135	107	79%
1	MBA students - Full-time/part-time - Distance learning	150 60	68 41	45% 68%
2	MBA graduates - Full-time/part-time - Distance learning	100 50	36 29	36% 58%
	Total	360	174	48%

The response rate of the primary research was satisfactory; 79% for the interviews; and 48%, for the questionnaires. There were two reasons. First, K Y Cheung had been teaching both full-time, part-time and distance learning MBA programmes for over six years in the Asia Pacific area. Many respondents knew K Y Cheung personally. Second, most of the respondents were used to researches, and welcomed the opportunities to express their views.

## 2.5 The Methodology

### 2.5.1 Interviews

Specific guidelines were given to the interviewers prior to interviewing the target population. Also, all interviewers, total three persons, including K Y Cheung had to attend a 2-hour training session about skills of interviewing, understanding the questionnaires, and how to answer questions raised by the interviewees.

An interview time was around 30 minutes, in a quiet seated environment. The major problem was the interviewees found it difficult to compare various MBA programmes, particular full-time/part-time and distance learning MBA programmes. As a result, we brought along many MBA programmes brochures to assist them in recognizing various MBA programmes. This proved extremely useful.

### 2.5.2 Questionnaires

We designed six types of questionnaires, with both selective and open-ended questions. These included:

- (1) Questionnaire for university MBA programmes teachers/administrators;
- (2) Questionnaire for local or regional operators of distance learning MBA programmes;
- (3) Questionnaire for students studying an MBA programme;
- (4) Questionnaire for MBA graduates;
- (5) Questionnaire for potential students wishing to study an MBA programme, and
- (6) Questionnaires for employers of MBA graduates.

### 2.5.3 Secondary data

Secondary data were mainly collected by reviewing past related literature, by desk researches on magazines and newspapers from USA, UK, Australia, Singapore, and China, including Hong Kong, Beijing and Taiwan. A list of the secondary data was given in Appendix 1. Web sites from the Internet related to the subjects were outlined in Appendix 2.

## 3. The Findings from the Original Research

### 3.1 The MBA Supply Chain Model

#### 3.1.1 The MBA Supply Chain Model

Figure 1 illustrates what constitutes the “MBA Supply Chain Model”. It starts from the supplier, the universities, with or without strategically allied with local

or regional operators to reach the potential students and ended at the employers of MBA graduates.

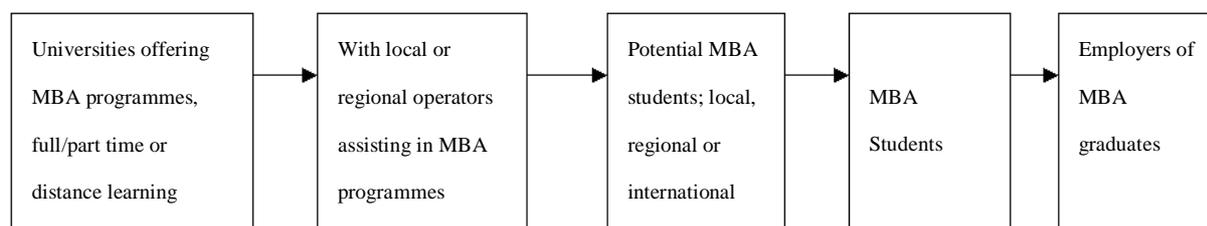


Figure 1: The MBA Supply Chain Model, with local or regional operators

The aim of setting up an MBA Supply Chain Model is to help analyzed where problems occur whilst applying various e-commerce techniques. It pinpoints problems areas, and gives quick answers to questions, where users are generally very time conscious. Also, in case of a breakdown in the system, solutions can be assessed and prioritized.

Each individual member of the MBA Supply Chain can solely determine how various techniques of e-commerce can be applied, as each designs and operates their own e-commerce system. For example, a university can target to have its enrolment procedure 75% electronically processed. Obviously, many of the related administrative work must backup with such an objective.

As there is no control over the degree of specialization and technical advancement in the e-commerce techniques throughout the MBA Supply Chain, often delays and technical problems occur. However, it would up to the individual member within the MBA Supply Chain to solve its own problems. Good co-ordination work among various members of the MBA Supply Chain thus becomes an integral part of operation, if they want an efficient system. This is particularly true for distance learning MBA programmes, where distance is a problem, time zone changes and students' culture varies.

## 3.2 MBA Programmes and E-commerce Techniques

### 3.2.1 Common types of e-commerce techniques

All the interviewed university teachers/administrators of MBA programmes confirmed that their programmes used various e-commerce techniques. The most common types of techniques are:

- (1) EDI for information processing and transmission;
- (2) Own web site/page for information building and dissemination;
- (3) Internet for search of information, particularly for assignments;

- (4) Inter-library information sharing; and
- (5) E-mail for communications.

E-commerce techniques were both important to full/part time and distance learning programmes. Over 90% of the interviewed university teachers now spent over one-third of their time on various e-commerce techniques. Sending, reading and answering e-mails topped their list. For university administrative staff and operators of distance learning programmes, the usage of e-commerce techniques were even higher, 65% of their working time. Same as university teachers, e-mail matters were the most time consuming for university administrators.

### 3.2.2 How e-commerce techniques help increase MBA programmes opportunities?

#### 3.2.2.1 The Opportunities

E-commerce techniques had made it possible for universities to expand their MBA programmes. This was particularly true in UK and Australian MBA business schools interviewed. 75% of the university teachers interviewed admitted that e-commerce techniques had directed helped in creating more MBA programmes, particularly distance learning and online programmes. A university's major consideration in providing more MBA programmes was the costs in administering and developing MBA programmes, whether local or overseas. Different e-commerce techniques had helped to reduce developing and running MBA programmes costs substantially, some even by 80%.

#### 3.2.2.2 Distance learning MBA programmes

A university could either offer a distance learning MBA programme by themselves or in collaboration with local or regional operators. The University of Western Ontario offered their MBA programme in Hong Kong by themselves. In contrast, the University of South Australia offered their MBA programme in Singapore in collaboration with the Asia Pacific Management Institute. With the aid of various e-commerce techniques, distance learning programmes were able to recruit students online,

liaise with students on a regular communication channel, and provide course materials where necessary. Warwick University in UK was one of the pioneers of distance learning MBA programmes with the aids of e-commerce techniques. As a participant on the Warwick MBA by distance learning, you will be required to have Internet access and an email address. We use these technologies extensively for both the academic and the administrative delivery of the programme.<sup>5</sup>

To be successful in distance learning MBA programmes, many universities and local/regional operators held regular video-conferences between students and the universities. These are particularly important before handing in of assignments and prior to examinations. Many overseas students found it necessary to talk direct to the MBA faculty, but without a formal communication channel. Face to face online video-conferences are good use of e-commerce techniques. The University of South Australia used this method for their MBA programmes in Singapore, Malaysia, Hong Kong, China and Taiwan, China.

### 3.2.2.3 Online MBA programmes

With good e-commerce technical backup, many universities pioneered into online MBA programmes. The City University of Hong Kong was a good example. Obviously using various e-commerce techniques were key to success. Although online MBA programmes were still not very common around the world, eventually it would gain importance.

### 3.2.2.4 Full/Part time MBA programmes

Many MBA programmes now introduced in their full and part time MBA curriculum, new courses related to e-commerce. The National Taiwan University MBA programmes had electives in e-commerce, multi-media and networking. Some business schools even pushed the emphasis further to form an e-commerce specialization. Nanyang Business School of the Nanyang Technological University in Singapore was a good example. The specialization focuses on developments in the Internet economy to equip both IT and non IT professionals with conceptual, applied and leadership skills needed for key positions in today's high-tech companies which position the Internet as a strategic resource. Besides learning how to build new Internet companies, participants will also acquire a multi-dimensional perspective in transforming traditional companies into modern e-commerce organizations.<sup>6</sup>

### 3.2.3 The intensity in using various e-commerce techniques

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<sup>5</sup> Learning Online, Warwick MBA by distance Learning, Warwick Business School, 2002, p 11.

<sup>6</sup> 2002 The Nanyang MBA, Nanyang Business School, Nanyang Technological University, Singapore, p 20.

From the study, MBA students used various e-commerce techniques most. The administrative matters of the MBA programme, the assignments to search information from the Internet, the liaison with fellow students and university teachers, all are via the Internet or the university's intranet, by e-mail or through EDI. For an MBA student, this might be the cheapest, most effective, and highly efficient way of studying. MBA students interviewed and questioned spent over four hours with the computer every day. Even if they were not busy, they still spent two hours per day on various e-commerce techniques, from e-mail to ICQ.

MBA teachers interviewed came second in e-commerce techniques usage, followed by administrative staff. There would be increasing demands for MBA teachers to fully understand, apply and utilize various e-commerce techniques in their teaching and research work.

### 3.2.4 Regional comparison in e-commerce techniques usage

In the study, Hong Kong, China MBA students used various e-commerce techniques most. One of the reasons might be the MBA students interviewed all had their own personal computers. Another interesting finding was on average a Hong Kong, China MBA student had 1.35 computer to use, including their own personal computer. This also suggested that availability of computers was crucial to e-commerce techniques usage. According to the findings of the study, Taiwan, China student came second in e-commerce techniques usage followed by Singaporean and Malaysian MBA students. Another interesting finding was over 80% of the MBA students interviewed used both English and Chinese languages in their computers. We could foresee that multi-languages would become popular in future e-commerce applications.

## 3.3. E-commerce Applications in MBA Programmes

### 3.3.1 Definition

MBA programmes having e-commerce application means during the process of providing MBA education, e-commerce techniques are applied to enhance the supply chain process, e.g. information flow of the MBA programmes. The most important e-commerce techniques encompass electronic data interchange (EDI) systems, value-added networks (VAN), the Internet, hypertext links, web-based technology and security issues.

### 3.3.2 Common e-commerce applications in MBA programmes

From the research findings, we understand that e-commerce applications in MBA programmes are

commonly found in three major areas, namely

- (1) in administration, whether university or local /regional operators;
- (2) in MBA teaching/learning between teachers and students and among students, and
- (3) in the provisions of a secure web-based environment, whether the university's web site/page or the Internet..

### 3.3.2.1 In MBA administration

#### 3.3.2.1.1 University MBA programme administration

To ensure that the programme administration was efficient, different e-commerce applications were introduced. Many MBA programmes constructed their own web sites and hyper-linked with their university main web site. The Melbourne Business School had their own web site, [www.mbs.unimelb.edu.au](http://www.mbs.unimelb.edu.au). This was the easiest method potential MBA students could obtain information from an MBA programme.

All the MBA teachers interviewed admitted that having their own web site/page was the best way to attract potential students, particularly regional and international students, where distance is a problem. Many provide instant email reply services whereby potential students could ask or request for information online, e.g. request for an MBA brochure or an application form. The University of Malaya was a good example.

Other applications included the creation and maintenance of data banks about potential MBA students. Relevant MBA admission materials could be sent to potential MBA students on time and regularly. This actually helped to promote the image of the MBA programme and directly assisted in finding the best students for the business schools. From the study, it was interesting to know that 72% of the potential MBA students actually enquire about an MBA programme via the Internet. 24% actually enrolled on the Internet. Over 90% of the MBA programme admissions staff expected this trend to increase substantially in the immediate future. How to build good web sites/pages and to maintain them became concerns of many business schools, as this would be one of the most popular media for MBA students to find information about their courses.

#### 3.3.2.1.2 Local and regional operators

Local and regional operators who act as an in between for university offering MBA programmes and MBA students used e-commerce applications most. One of the major functions of the operators was to quickly inform university MBA programmes about the feedback of their students. This was particularly important to distance learning MBA programmes. For example, the Hartford Group of Institutions claimed their "MyElearningPortal" was the only online educational platform in Asia to

effectively provide up-to-date information and services for their currently enrolled student's to access their programme information online. Originally, students were encouraged to e-mail the questions to the operators, then onward to the relevant university staff, whether administration or teaching. Now, many universities face students direct, particularly on course questions.

Over 50% of the operators interviewed admitted that their work had been more administrative, as compared with 2-3 years ago. They usually organized video-conferencing meetings on a regular basis, collected assignments before deadline, placed advertisement after approval from MBA programmes, and provided local admission services. Some operators like Global Education also maintained a chat room, whereby students could freely expressed their views. Comments from these chat rooms could be used to improve future administration efficiency.

To ensure quick response with potential and studying MBA students, operators maintained a web site with email address where they could answer queries immediately, e.g. the Informatics Group in Singapore. All operators interviewed claimed that they could handle requests, e.g. application forms, immediately. Potential MBA students could download the information instantly from their web sites.

### 3.3.2.2 In MBA teaching and learning

#### 3.3.2.2.1 MBA teaching

All of the MBA teachers interviewed agreed that e-commerce applications had upgraded the quality of teaching. With a web-based environment, teachers could prepare more up-to-date information for students. The costs for collecting and collating teaching materials were reduced substantially, especially when an electronic library was available. Students could access to reading materials, journals and research work on a 24-hour time frame, thus better utilizing the student's time. MBA teachers in Hong Kong, China particularly liked to put teaching materials on web sites. The Open University of Hong Kong had an electronic library whereby MBA students could link at will.

E-commerce applications could help to enhance the contents of an MBA programme. Teachers could now collect more information via the Internet. During class lectures, demonstration of cases using online Internet technology was a very effective way of teaching. All students interviewed and questionaired regarded the ability to demonstrate a concept online to be a great improvement in teaching. Also for students, seeing was believing. In the study, 75% of the MBA teachers interviewed who taught Marketing courses used many e-commerce applications, some even as much as 30% of the lecture time or more.

In actual MBA course designs, teachers interviewed now

had to consider various types of e-commerce applications in their course curriculum. Some would require students to do presentation work, but with Internet assistance. Others would ask students to collect and collate information from the Internet. All indicated that e-commerce applications were today's trend in MBA course designs. This would be particularly true for MBA programmes that emphasized on recruiting international students and with globalised courses. The University of Singapore MBA programme would be a good example.

Apart from course materials, some MBA teachers allowed their students to hand in their assignments using soft copies. This could be more environmentally friendly, as less paper was involved. This also encouraged the students to use coloured graphics, more appendices and web site references in their assignments. Less administrative work could also be involved. The only drawback could be the argument about whether an assignment had been handed in, if records from the computer could not be traced.

#### 3.3.2.2.2 MBA learning

MBA students benefited most from various e-commerce applications in their study, including lessons preparations, presentations, group work and assignments. If an electronic library facility was available, students could study at will, ignoring the opening and closing hours of a traditional library. In searching for information, the Internet usually had more than enough data for students to collect. How to be selective in data collection would be a skill MBA students had to master. A point of caution was that students had to observe the international copyrights issue when downloading any information. Many universities had strict rules governing the copyrights issues.

Many MBA courses required students to do oral presentations as part of their grading system. The study found that presentation marks could go as high as 40% or more of the course grade. Many students used different computer groupware, e.g. Microsoft Office 2000, in their presentations. Microsoft's PowerPoint was the most commonly used. Together with other software by the same manufacturer, a student could compose a very attractive presentation, with immediate Internet connection, making the presentation very animated and lively. Also, with a coloured screen, the effects and quality of the presentation would automatically be upgraded. Such presentations had become a standard norm in MBA presentations.

Group work was a major characteristic of MBA studying. Students had to liaise with each other on a very regular basis. Emails played the most important role in connecting students, whether living inside or outside the campus. The enclosure of files in emails allowed students to incorporate large amount of data that was not

possible years ago. This helped to prepare large amount of data easily and cheaply. The convenience and low costs encouraged students to search, analyze and use data frequently. The quality of MBA group work had been greatly upgraded. The continual upgrading of transmission speed had directly encouraged the more common usage of various e-commerce applications.

The quality of an MBA assignment had improved tremendously during the past two to three years. Many assignments were liked published works, as the use of coloured diagrams, graphics and enclosures became popular. The settings of the assignments, the quality of printing and the onerous drawing of outstanding diagrams and tables, all showed how e-commerce applications could help to upgrade the quality of an MBA assignment. Students had to master good e-commerce application skills to survive in a very competitive academic environment. This would be particularly true for subjects like Marketing, Economics and Logistics Management where pictures and diagrams helped to express the meanings of theories and concepts. Over 80% of the studying MBA students interviewed and questionnaired admitted that they had to produce high quality coloured assignments.

#### 3.3.2.3 Providing a Secured Intranet System

##### 3.3.2.3.1 Web-based technology

All the university teachers/administrators and local/regional operators interviewed confirmed that they all had their own web sites. The results of the study also indicated that there was an increased risk in web-based electronic commerce. Two universities administrators interviewed said their universities had been victims of information losses. As such, continuously developing and maintaining a high quality secured web-based technology was crucial to the successful development of e-commerce applications in MBA programmes. The limiting factor of most MBA programmes was that they had to be an integral part of their university web site, unless they could afford their own web sites, if approved by their university.

For local and regional operators, they could be more flexible in web sites designs and operation. Installation costs were the major initial concerns. All of the local/regional operators interviewed admitted that ensuring a 24-hour 365-day web-based environment was key to their success, as most of their students would contact them any time of the day, and more frequently after office hours and in holidays. However, this could be a serious problem, if the technological hardware and software between universities and local/regional operators were not commensurable. Also, the level of technical competence of the service providers, local or international, could make a big difference.

##### 3.3.2.3.2 Internet and Intranet Security

Internet and intranet safety had always been a problem in e-commerce applications. Traditional security measures, e.g. firewalls, cryptography and authentication still played the most important role in network protection. Anti-virus operations played a significant role in e-commerce applications like e-mail transmission. As a precaution, some university scanned all incoming and outgoing e-mails as a requirement. As the intranet system would be used by a very huge number of users, e.g. administrators, teachers and students, maintaining a secure system became crucial and difficult.

How to maintain a highly secured intranet system was the major concern of all the people interviewed and questionnaired. Internet security was also extremely important. Protecting the privacy of a user was top priority. Also ensuring 100% of document transmission without being hacked was another priority issue.

### 3.3.2.3.3 Internet and Intranet usage regulations

Depending on locations, different countries had different e-commerce laws. It would be understandable that the control of the Internet would be difficult. Internally, the university's control of its own intranet could be easier. All the university teachers/administrators interviewed confirmed that their universities had guidelines about Internet and intranet usage. Offenders could be easily traced, and disciplinary actions would be taken, if necessary. As such, constant updating of Internet and intranet usage regulations would be necessary to maintain efficient and secured systems.

### 3.3.2.3.4 Operating and maintenance costs

Operating and maintenance costs of the Internet/intranet system were the second major concern of the university teachers/administrators interviewed. University budgets were usually very tight. Constant upgrading of an Internet/intranet system might not be possible, especially when most of the MBA programmes were but part of a university's computer system.

There would be situations where other members of the MBA Supply Chain were technically current; but the source of the MBA Supply Chain, the business schools, lagging behind. This would create many problems, especially when software was not compatible in either old or current systems, e.g. Windows 95 versus Windows 2000. One interesting findings was that all the interviewed or questionnaired remarked they used English and Chinese (either simplified or traditional) as their medium of communication. Microsoft Explorer would be their first choice of the browser, followed by Netscape Navigator.

## 3.4 The Benefits and Problems of Applying E-Commerce Techniques into MBA programmes

### 3.4.1 The benefits

From the research findings, university teachers/administrators remarked the benefits of applying e-commerce techniques into MBA programmes in order of importance are:

- (1) To maintain the image of the business school and the MBA programme,
- (2) To reduce costs substantially,
- (3) To increase the competitiveness of students,
- (4) To provide a regular channel of communication,
- (5) To create programme opportunities, and
- (6) To make their curriculum more globalised and practical.

MBA students interviewed or questionnaired admitted that the most important benefits from their MBA studies were the increase in their personal competitiveness. Globalisation was now the trend. E-commerce techniques and applications were "musts" for executive nowadays. All employers of MBA graduates interviewed considered the e-commerce competitiveness of MBA graduates one of their reasons why they were willing to pay them a higher salary package.

### 3.4.2 Associated costs and problems

#### 3.4.2.1 Associated costs

The benefits from applying e-commerce techniques into MBA programmes had associated costs. First, web sites had to be created, with proper operating and maintenance costs. Second, the opportunity costs involved in ensuring a safe and efficient system were worth considering. Third, future-upgrading costs meant more investments must be allocated. The budget for these costs would become a major concern for all parties in the MBA Supply Chain, as each party would be affected. This would be particularly true for MBA programmes treated as a self-funding project.

#### 3.4.2.2 Related Problems

From the study, the following problems with applying e-commerce techniques into MBA programmes were identified:

- (1) MBA teachers must understand the various e-commerce techniques, and capable of applying them into the curriculum,
- (2) How and who are to ensure that the MBA Supply Chain members had compatible e-commerce application capabilities,
- (3) The technical expertise to backup the hardware and software systems of the Internet/intranet systems of universities and local/regional operators,
- (4) The degree of computerization of the MBA programmes supply and demand countries, and
- (5) The budget situations of different MBA Supply Chain members.

No solutions were found, except that MBA teachers had to self learn to upgrade themselves regularly on various e-commerce techniques and applications to remain competitive. How to solve the abovementioned related problems could be a good future research area.

### 3.4.3 Building MBA student's personal competitiveness

All of the MBA employers interviewed were looking for different competitiveness MBA graduates had acquired. These included good international management giving trained analytical skills; globalised thinking, an ability to handle change; innovation in work process; and entrepreneurial capability. E-commerce applications in MBA programmes had helped to create such competitiveness. Constant exchanges of information and ideas internationally through the Internet made MBA graduates accustomed to the international market. With globalised thinking, the world would be closer together, and more business opportunities.

Over 92% of the students studying MBA programmes interviewed and questioned agreed that e-commerce applications increased their personal competitiveness by giving them the opportunity to create a more practical world and be innovative. The constant involvement in international matters through the Internet made students more accustomed to how to deal with globalised situations and matters. The globalised thinking learning curve effect could be best seen when MBA students

graduated.

The study clearly reviewed that the personal competitiveness of MBA graduates would be a direct result of a carefully designed university's curriculum. From MBA graduates interviewed and questioned, all concluded the course emphasis was key to building their personal competitiveness. These included: (1) trained analytical skills to differentiate their abilities, (2) globalisation understanding to analyse different environmental situations, (3) ability to handle change effectively, (4) entrepreneurial in work attitude, (5) innovative to survive, and (6) networking through their alumni to add value. E-commerce applications in the curriculum played a very major role in building all these competitiveness. We could conclude that e-commerce applications into MBA programmes would be a must for any MBA programme to be highly successful.

## 4. The Findings from Desk Research

### 4.1 Analysis of different MBA brochures in Asia

Many MBA programmes were offered in Asia, including countries like Singapore, Malaysia, Australia, Thailand, Hong Kong, China and Taiwan, China. We had taken 54 MBA programme brochures offered in Asia, and made the following comparisons:-

Comparisons	Australia (Distance learning)	UK (Distance learning)	USA (Distance learning)	Hong Kong, Taiwan, China	Malaysia and Singapore
(1) Coloured brochure	16	12	8	12	6
(2) Introduction about the University and programme	16	12	8	12	6
(3) Clear mission statement	12	10	5	10	4
(4) Building competitive advantage of students	6	8	5	8	3
(5) University and operator information together	10	8	5	4	0
(6) Outline MBA programme structure	16	12	8	12	6
(7) Mention about the research capability of the University	1	1	0	6	2
(8) Entry requirements	16	12	8	12	6
(9) Duration	16	12	8	12	6
(10) Fee schedule	12	5	4	10	3
(11) Application procedure	16	12	8	12	6
(12) Selection procedure	8	7	5	10	3
(13) Rankings by third parties	7	5	0	7	2
(14) Faculty list	6	5	2	5	2
(15) Administrative support	14	10	7	10	5
(16) Academic recognition	12	5	5	12	4
(17) Introducing studying MBA students	0	0	0	6	1
(18) Past student profile	0	0	0	4	1
(19) About graduate employers	2	0	0	0	0
(20) Alumni networking	1	0	0	5	2
Total number of brochures analyzed	16	12	8	12	6

Table 1: An analysis of various MBA brochure

Note: Number inside table is actual counts. The analysis suggested that many of the key selling points of full-time and part-time MBA programmes were not stressed in the brochures. These include acquiring competitive advantage, career services, and alumni networking. Also student profiles were not disclosed.

## 4.2 Review of related MBA literature

There have been very few researches on MBA studies as a research topic. Many business schools do have their perceptions on MBA development, but most of them are confidential and unpublished. Commercial studies on MBAs related mostly to rankings about course evaluations, teacher's background, research capabilities, etc. However, if the business schools chose not to participate in academic and/or commercial assessments, then it would be very hard to compare business schools as a whole.

## 5. Conclusions and Implications of the Research Findings

### 5.1 Conclusions

The conclusions of the research findings were:

- (1) MBA programme in Asia is a rapid growth area, and will continue to grow in the coming decade, especially in countries changing towards a knowledge economy.
- (2) An e-commerce education model can help to better understand how we can utilize the concepts of supply chain and e-commerce technology in MBA programmes.
- (3) E-commerce technology has positively affected the growth of MBA programmes, particularly distance learning and online programmes in selected Asian countries and creates many opportunities worldwide.
- (4) The supply chain of distance learning and online MBA programmes rely heavily on e-commerce technology.
- (5) In full-time, part-time, and distance learning MBA programmes, teachers required students to access information from the Internet. Many MBA courses must have university technical support to be successful.
- (6) Globalisation of MBA programmes cannot be successful without e-commerce technology. Many MBA teachers and students contacts are via the Internet. This globalisation knowledge will give MBA graduates a competitive advantage after graduation
- (7) In the design of MBA curriculum, teachers must have some knowledge about the technical aspects of e-commerce. This can be demanding to some MBA teachers.
- (8) In MBA education, speed of information is crucial to both students and teachers. Information technology will gradually change the needs and wants of both teachers and students.
- (9) Online distance learning MBA programme is still unpopular. The combination mode of teaching is dominating the trend in distance learning MBA education.
- (10) Government regulations on e-commerce can affect information flow, and adversely affect the development of MBA programmes. Security of information is a concern of both teachers and students.

### 5.2 Implications

The conclusions have a number of implications. First, e-commerce technology makes MBA education competition global. Second, understanding the supply chain and local responsiveness in selected Asian countries will affect the design of MBA curriculum. Third, MBA graduates expect their programmes can give them globalisation knowledge to improve their personal competitiveness. Emphasis on an MBA programme will be more global and strategic. Fourth, universities will have to spend more resources on e-commerce technology to remain competitive. This can be a financial burden. Fifth, with plenty of information available through the Internet, teachers need to upgrade themselves at a very quick pace. This can be very demanding to the academic staff. Sixth, development of online distance learning MBA programmes is limited by both hardware facilities and curriculum design. Seventh, different government regulations on e-commerce can affect information flow internationally, and adversely affect MBA development internationally. Finally, Internet security can be a problem in developing distance learning and online MBA programmes.

## 6. A Look Ahead

The MBA programmes in Asia will continue to grow rapidly, e.g. in Singapore and Hong Kong, China, especially when the trend towards a knowledge economy is a natural extension of many economies. The major challenge ahead for business schools in Asia is to design MBA programmes suitable for their local needs in a fast changing technological environment. For countries concentrating on distance learning programmes, the challenge is even more, as both local and regional/international conditions have to be satisfied. More continuous researches into the MBA topic area can help to formulate better strategies for individual Asian business schools searching for their own characteristics; and can create more co-operation among world educators.

## Appendix 1: Review of MBA Literature

### (A) English and German Books

- (1) Peter G. Forrester, *The British MBA : an assessment of postgraduate management education in UK universities*, Cranfield : Cranfield Press, 1986.
- (2) Lau Sui-yin, Eddie, Chan Wan-kam, *Computer systems recommendations for the MBA programme : research report*, Hong Kong : Chinese University of Hong Kong, 1982.
- (3) Leung Kin Hee, *The conflict between business graduates and companies : a study on MBA of Hong Kong by behavioral approach*, Hong Kong : Chinese University of Hong Kong, 1973.
- (4) Nedda Gilbert, *The best 80 business schools*, New York, NY : Random House, Inc., c1999.
- (5) Robin S. Snell and Agnes Lau, *A brave experiment in a barren environment : evaluating a self development module on an MBA in Hong Kong*, Hong Kong : Dept. of Business and Management, Faculty of Business, City University of Hong Kong, [1995].
- (6) *CUMBA evolution, 1966-1988*, [Hong Kong : MBA Alumni Association of the Chinese University of Hong Kong], [1989?]
- (7) Leonard M. Lodish, Howard Lee Morgan, Amy Kallianpur, *Entrepreneurial marketing : lessons from Wharton's pioneering MBA course*, New York : Wiley, c2001.
- (8) Birgit Giesen, Nicola de Menezes, Kirstin Rappmund-Gerwers ; [Herausgeber, Joerg E. Staufenberg], *Europäische Studiengänge und MBA-Programme in Europa*, Köln : Institut für Berufs- und Ausbildungsplanung, 1995.
- (9) *Financial times mastering strategy : the complete MBA companion in strategy*, Harlow : Financial Times/Prentice Hall, 2000.
- (10) Susan Cohn, Don Hudson, *Finding your way with an MBA : insights from those landing their ideal jobs*, New York : J. Wiley, c2000.
- (11) Robyn Frank-Pedersen, *M.B.A. part-time : an insider's guide*, New York : Simon & Schuster, c2000.
- (12) *Mastering global business : the complete MBA companion in global business*, London : Financial Times/Pitman Pub., 1999.
- (13) *MBA*, Chagrin Falls, Ohio : MBA Magazine, Inc., 1966-78.
- (14) E. Raymond Corey, *MBA field studies : a guide for students and faculty*, Boston, Mass. : Harvard Business School Pub. Division, c1990.

- (15) Sheila Cameron, *The MBA handbook : study skills for postgraduate management study*, Harlow, England ; New York : Financial Times/Prentice Hall, 2001.
- (16) Stuart Crainer and Des Dearlove, *MBAplanet : the insider's guide to the business school experience*, London : Financial Times Prentice Hall, 2001.
- (17) Jodi Z. Krasna, managing editor ; Sarah A. Dallam, copy editor ; James W. Schmotter, *The official guide to MBA programs*, [Los Angeles, Calif.] : Graduate Management Admission Council, c1994.
- (18) *The official MBA handbook*, Harlow : Pearson Education, Ltd., 1999-
- (19) *Peterson's guide to MBA programs*, Princeton, NJ : Peterson's, c1995-
- (20) *Peterson's ... MBA distance learning programs*, Princeton, N.J. : Peterson's, c1999-
- (21) Chan Lai-ying, Rita, *A study on MBA programmes in Hong Kong*, Hong Kong : Chinese University of Hong Kong, 1993.
- (22) George Bickerstaffe, *Which MBA? : a critical guide to the world's best MBAs*, London : Pearson Education ; New York : Economist Intelligence Unit, c2000.

### B. Chinese Books

- (1) 吳世農, 全允桓 《中國 MBA 教育實踐與探索》 機械工業出版社 2001
- (2) Niting Nuoliya (Nitin Nohria) bian ; Liu Shiping yi ; Xu Shijun zong xu ; Lin Yingfeng dao du, *MBA bai ke quan shu 《尼汀{21232e}諾利亞(Nitin Nohria)編 ; 劉世平譯 ; 許士軍總序 ; 林英峰導讀, MBA 百科全書 》*, Taipei Shi : Shang zhou chu ban, 2000. 《臺北市 : 商周出版, 2000.》
- (3) *MBA yan jiu zhong xin zu bian ; zhi bi ren Ouyang Zhiming, Zhao Yonghui, Liu Lengyi., Quan qiu shi da shang xue yuan 《MBA 研究中心組編 ; 執筆人歐陽志明, 趙永慧, 劉冷一, 全球十大商學院》*, Beijing shi : Qi ye guan li chu ban she, 1998 《北京市 : 企業管理出版社, 1998.》
- (4) 全元桓 〈認清發展趨勢, 加快MBA教育改革和發展〉 《中國高等教育半月刊》 2002(1)
- (5) 〈中國高校工商管理碩士學位(MBA), 教學合格評估(第二批) 結果揭曉〉 《學位與研究生教育》 2001(12)
- (6) 沈遠平 〈淺談 MBA 管理溝通課程教學〉 《學位與研究生教育》 2001(7-8)

(7) 曾詠梅 〈我國 MBA 法學課程的設置與教學改革〉  
《學位與研究生教育》 2001(6)

(8) 楊斌、趙純均 〈美國 MBA 校友網路建效介紹〉《學位與研究生教育》 2001(4)

(9) 於立 〈財經類院校如何辦存 MBA 教育—東北財經大學的探索〉《學位與研究生教育》 2000(6)

(10) 葉明海 〈MBA 營銷管理課程教學的若干思考〉  
《學位與研究生教育》 2000(3)

(11) 鄭潔 〈淺談我國 MBA 課程設置中的不足〉《學位與研究生教育》 1999(6)

(12) 王子成、陳莞菁、蔣慧 〈MBA”聯考”與”GRK”實行聯合的必要性和可能性〉《學位與研究生教育》 1999(6)

(13) 朱金生 〈“案例教學法”及其在我國 MBA 教育中的作用〉《學位與研究生教育》 1999(6)

(14) 袁衛、何曉群 〈MBA 應用統計教學的實踐與體會〉  
《學位與研究生教育》 1998(6)

(15) 趙錫斌 〈改進 MBA 案例教學的新思路〉《學位與研究生教育》 1998(5)

(16) 徐松、田鶴亭、宋曉平 〈MBA 論文質量分析及其相關問題—西安交通大學 MBA 論文評審與討論會綜述〉《學位與研究生教育》 1998(2)

(17) 李寶山 〈加強 MBA 整合能力的培養〉《學位與研究生教育》 1998(1)

(18) 王秀村 〈倫敦商學院的 MBA 教育及其啓示〉《學位與研究生教育》 1997(6)

(19) 楊錫懷 〈一九九六年美國優秀商學院排名及啓示〉  
《學位與研究生教育》 1997(5)

(20) 陳榮秋 〈管理者的素質和 MBA 教育質量〉《學位與研究生教育》 1997(5)

(21) 李延喜、遲國泰、樂慶偉 〈全過程管理, 多方住控制, 提高 MBA 教育質量〉《學位與研究生教育》 1997(4)

(22) 張文修 〈提高 MBA 培養質量是發展 MBA 教育的關鍵〉《學位與研究生教育》 1997(3)

(23) 楊金麗、馬秀玲 〈從哈佛看我國的 MBA 教育〉《學位與研究生教育》 1997(3)

(24) 顧永才 〈試析我國試點 MBA 教育存在的不足〉《學位與研究生教育》 1997(2)

(25) 周三多 〈中國 MBA 入學綜合考試改革初探〉  
《學位與研究生教育》 1996(3)

(26) 魯明泓 〈美國管理研究生入學考試(GMAT)

Appendix 2: Websites Related to MBA Programmes

- (1) [www.21ce.net](http://www.21ce.net)
- (2) [www.sina.com.cn](http://www.sina.com.cn)
- (3) [www.embark.com](http://www.embark.com)
- (4) [www.asiaweek.com](http://www.asiaweek.com)
- (5) <http://unicorn.us.com/guide/>
- (6) <http://www.gmat.org/>
- (7) <http://www.foreignmba.com/>
- (8) <http://www.mbainfo.com>
- (9) <http://www.embanet.com>
- (10) <http://www.cuhk.edu.hk/mba>
- (11) <http://www.petersons.com/mba/search.html>
- (12) <http://www.getMBA.com>
- (13) <http://www.mba360.com/>
- (14) <http://www.mba-programs-online.com>
- (15) <http://www.execmba.com>
- (16) <http://www.top10.org>
- (17) <http://www.MBA.CollegeEdge.com/>
- (18) <http://www.singaporemba.com/>
- (19) <http://www.edupak.net/>
- (20) <http://www.euro-mba.net/>
- (21) [http://hops.wharton.upenn.edu/programs/mba\\_program.html](http://hops.wharton.upenn.edu/programs/mba_program.html)
- (22) <http://www.mbaentry.com/>
- (23) <http://www.buseco.monash.edu.au/>
- (24) <http://www.ebs.de/>
- (25) <http://www.aim.edu.ph/>
- (26) <http://www.mbasystems.co.uk/>
- (27) <http://www.b-school-net.de/>
- (28) <http://www.em-lyon.com/>
- (29) [http://business.missouri.edu/mba\\_assoc/](http://business.missouri.edu/mba_assoc/)
- (30) <http://www.insead.com/>

# Importance of the Internet in University Curriculums: A Case Study at Sam Houston State University

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## Abstract

The advances in technology today have made the use of the Internet important in almost every discipline. Educators, business people, scientists and those in the criminal justice field all rely on the Internet to help them perform their jobs to the fullest. The Internet is immense and has many uses that can assist student in each discipline. Knowledge of the Internet and the full extent of its capabilities are important to anyone entering the workforce in today's technologically advanced environment. In order to keep their graduates competitive in this environment, it is important that universities offer courses which not only cover the basics of Internet use but also show how the Internet can help them advance and excel no matter which field they enter. The current lack of a course for all students which covers in-depth internet use opposed to the number of fields that utilize the Internet, and the extent to which they use it, exposes the need for a course to better prepare students for the changing environment they will enter after graduation.

## 1. Introduction

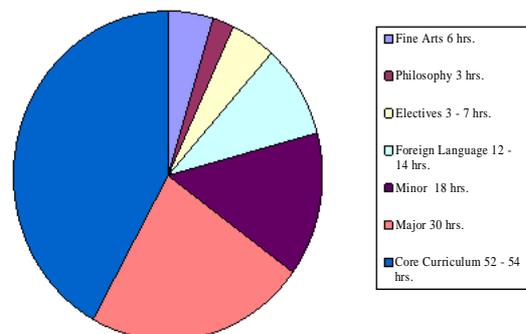
The Internet is "a network of computers interconnected throughout the world operating on a standard protocol that allows data to be transmitted" (Kotabe and Helsen, 2001, 604). The Internet is widely regarded as the greatest invention of the 20<sup>th</sup> century. Since its introduction to the general public in 1990, the Internet has become one of the most widely used tools in many disciplines. The ease of access and amount of information coupled with reduction in prices for both hardware and software has made the Internet invaluable to many professions. Regardless of ones field of study or discipline, the Internet is likely to be used on a regular basis in today's dynamic environment. The Internet is "altering the way companies reach their customers, affecting advertising, shopping, distribution and the way companies communicate with one another and with their staffs" (Cairncross, 1997, 119). Marketing over the Internet is expected to continue to grow, and it is "estimated that even taking into consideration the slowdown of the Internet economy, global business-to-business transactions in 2003 could reach about 6 trillion dollars" (Castells, 2001, 65).

The complexities of this new medium and its growing significance and importance make it especially important

that all university graduates have a full understanding of (which should include not only the opportunities available, but also the limitations and dangers posed by) the Internet. Currently, most US Universities require that all students (irrespective of their major) take a basic computer literacy course (e.g., Introduction to Information Systems, Introduction to Computer Science, Introduction to Library Science, etc.). Most of these courses teach freshman students application software (e.g., Word and Excel), how to send and receive e-mail, and how to use a browser and access the World Wide Web. While a computer literacy course is needed and necessary, such a course only skims the surface of the important and vast uses of the Internet. It is in our opinion that a second mandatory course titled "Introduction to the Internet", which focuses solely on the Internet and related applications (e.g., Intranets and Extranets) would be invaluable to university students pursuing a Bachelor's degree.

The following pie charts show the current breakdown of classes at a state supported institution of higher education (i.e., Sam Houston State University, Huntsville, Texas). The example uses the Bachelor's of Arts degree plan to express the division of hours. While each college may have a slightly different plan of hours, most require the fulfillment of a core, mandatory curriculum, major and minor degree hours and a varying set of electives. This pie chart shows the 128 hours required to graduate as they currently stand (i.e., without an Introduction to the Internet class). The largest section of hours a student takes is clearly the core curriculum, which is intended to give every student, regardless of major, an understanding of each field of study and ability to function in a complete manner in the professional world.

Current Bachelor's of Arts Degree Requirements



Students currently graduating with undergraduate degrees may not have all the skills necessary to be successful in today's competitive environment. Although they have taken the classes designed to make every student competent in a variety of areas, they can be lacking in a field that is quickly growing. Students graduating today must be prepared to utilize the Internet to its full potential. The widespread use of the Internet is quickly placing anyone with only marginal knowledge of its uses at a competitive disadvantage. The creation and utilization of a cross-disciplinary "Introduction to the Internet" class, that every student takes as part of their core curriculum, may help to prepare students better, regardless of their major field of study. The primary purpose of this class would be to introduce all students to the basic principles of the Internet (i.e., posting web pages, validating information downloaded, privacy and security issues, E-commerce transactions, etc.).

In an effort to express the penetration of the Internet into a wide variety of disciplines, the following sections review a few of the uses of the Internet in a selected number of disciplines (i.e., majors) taught at Sam Houston State University. The self-selection of the disciplines was done to provide a representative sample of the types of degrees offered at typical four-year academic institutions in the US. It can be argued that illustrating the importance and uses of the Internet in a selected few disciplines makes it equally important for any student pursuing a degree at a university to be competent in the new technology. The various uses of the Internet by businesses today reflect the need for a required comprehensive course at the university level to prepare students for successful careers. Understanding the various uses of the Internet is also critical from a consumer's perspective so as to make better (more informed) decisions. Next, we will highlight the various applications of the Internet to the following disciplines: Education, Literature, History, Sciences, Criminal Justice, and Business.

## 2. Education and the Internet

The Internet has become a tool used by many educators in classrooms at every level of education (from freshman to post-graduate). College Professors assign online exercises and post their syllabi and course material on their websites. Distance learning courses are offered at most large universities, and some college degrees can now be obtained online with no actual class time required (e.g., University of Phoenix). Educators in grades K-12 are also finding uses for the Internet in their classrooms. Children can communicate with experts and with students in other classes via computers (e.g., <http://www.OnlineClassroom.com>). Even disabled children are able to experience the benefits of the Internet with new advances in software. The Internet is opening up new ways to educate and explore material in and out of classrooms.

All schools, colleges, and Universities have embraced the Internet and use it extensively to maintain a

differential advantage. Almost every University has a web page ([www.shsu.edu](http://www.shsu.edu)), and many offer online classes. Students who work full-time can finish their degrees without having to attend physical classes. University students can also interact with professors through e-mail, virtual chat room, and posting of FAQ on websites. In the 1997-98 school year alone "more than 27,000 college-level courses were delivered over the Internet" (Woolf and Lesser, 2002, 2). Universities that do have actual classes, which meet often, assign research that requires the use of the Internet. Many professors post their class assignments on their personal web pages.

Educators in grades K-12 often use the Internet as more of a teaching tool. Recently a "study by Interactive Education Systems Design found that over 40 percent of high schools already offer online courses or plan to during this year" (CyberAtlas, 2002). Web sites offer lesson plans and online activities in collaboration with cities ([www.thirteen.org/wnetschool](http://www.thirteen.org/wnetschool)). Internet teaching companies like OnlineClassroom offer interactive guides for students and teachers in K-12. Students can interact with other classrooms or ask question of experts in certain areas if they sign on during a demonstration. Students can be exposed to different cultures and fields of study as they gain computer literacy skills.

Teachers in K-12 can teach their students how to use the Internet to their advantage. Students can learn how to quickly obtain quality material as well as how to judge the reliability of the information they discover. Some Universities (e.g., Purdue University) offer online guides and tutorials that teach students how to judge Internet material based on a "basic model emphasizing and integrating topic definition, information seeking, and evaluation" (Brandt, 2002). Teachers can give their students the safety guidelines, utilized by Purdue University and others, which they will need to navigate the Internet on their own through guided in-class instruction. The Internet has a wealth of information, but not all of it is legitimate or appropriate/suitable for everyone (e.g., children).

Teachers may also find that their ability to assist students with disabilities improves with the use of the Internet. Many educational Internet sites are geared toward students who have learning disabilities. The Parent Education Network (PEN) has compiled a database that directs those with disabilities to helpful websites, like *The Boulevard* geared toward those in wheelchairs (PEN, 2001). Software to assist the blind in navigating the Internet is available as well as headphones and captions that assist the deaf. For a student who is physically challenged, the Internet may present an opportunity to interact with others and "see things", which they otherwise would be incapable of experiencing.

The Internet also opens up many possibilities to educators. Distance learning and online classrooms offer new and interesting ways to present material to students. Teachers can now attend online classes, which present them with ways to enhance their students' learning experience through the Internet. It is important that teachers have a comprehensive understanding of the

Internet in order to communicate sound advice to their pupils. Universities now expect their students to be knowledgeable in online research, and many Universities offer classes that take place completely over the Internet. The Internet is quickly becoming a necessary tool in the education system, and soon no child's education will be complete without knowledge of the uses and pitfalls of the Internet.

The importance of the Internet in education is continued in the realm of literature. Literature and education are closely related for all those teaching or interested in teaching. The Internet is a tool that those concerned with or attempting to study literature can use to advance their knowledge. The next section outlines the uses of the Internet in relation to the literary field.

### 3. Literature and the Internet

The use of the Internet has greatly affected the literary field. The speed and ability to reach new customers that the Internet offers makes it an ideal new market for writers and publishers. Research, which traditionally had to be done in a library, can now be achieved online as articles and journals become available electronically. Teaching literature and encouraging children to read using the Internet has also had an impact on the literary field. The use of the Internet is rapidly transforming the literary world and allowing literature to remain current in a quickly changing world.

Both writers and publishers have realized the importance of the Internet as a tool to expose their work to wider audiences and as a new way to market their product. Writers are also taking advantage of the Internet by pursuing a multiple distribution strategy, by giving special offers at online bookstores and publishing seek-peek chapters of their novels to entice readers into purchasing. Novices are grabbing attention by displaying their work online in the hopes that readers will purchase their next work or that publishers will stumble across them and offer them contracts. The *Internet Public Library* and *Bookwire* both offer Reading Rooms in which thousands of complete online texts are available (Flack, 2002). Large publishing houses like Penguin Putnam Inc. are using their home pages as a channel of distribution to display the work of their new writers, offer background information and to sell directly to their readers (PenguinPutnum, 2002).

Other online retailers have realized the benefits of selling directly to their customers as well. While bookstores and libraries were once the only ways to obtain literature, the Internet has opened up an entirely new showcase. Readers can use search engines to find novels or go to any major online bookstore (e.g., Amazon.com or Barnesandnoble.com) to find the book they are looking for and have it delivered. Most online bookstores also sell student textbooks, making it easy for college students to purchase their textbooks online and avoid monopolistic campus bookstores.

Library research has also been greatly affected by the Internet. While research once required a trip to the local

library and hours at the card catalogue, it is now possible to do most research from the convenience of your home or office. Internet websites like the Librarians' Index to the Internet, which offers "more than 10,000 Internet resources selected and evaluated by librarians for their usefulness to users of public libraries," can help researchers evaluate their research material (Schneider, 2002). Professional Literary Journals and many novels are available in full-text on the Internet. Large libraries offer online tours and give readers the option of checking out their books through inter-library loan programs. A reader in a remote region can checkout a book from a major library with the help of the Internet. Most magazines and newspapers also make their material, as well as archives of their past articles, available online. With the use of the Internet, the time necessary to research has decreased as the amount of information available has increased.

As the Internet continues to change the availability of literature and decrease the difficulty of attaining quality work quickly, its use as an educational tool concerning literacy has increased. It has become easier to obtain literature and expose students of all ages to great works for a fraction of the cost of obtaining hard copies of the original literary works. Student Internet literacy programs have increased as schools make Internet access a regular part of their curriculum. Students are now taught Internet researching skills and are exposed to a wider range of material at an early age. The Internet has the ability to make literacy in schools easier to achieve through online programs as well as provide students with a greater range of interesting materials.

In summary, the Internet is having a great impact on the world of literature. Through use of the Internet, literature has become easier to obtain from online bookstores and libraries. Research in the literary field has been made easier by online literary journals and magazines, which offer full-text articles. Even teaching literature in schools and Universities has been affected by the availability of literature and research materials. The literary work has become more easily accessible through the Internet, and anyone training to enter the literary field must be competent in the uses of the Internet.

#### 3.1 Historians and the Internet

The discipline of studying and recording historical events has changed quickly in the last few decades. A major source of this change has been the invention and the increased use of the Internet by historians. Educating students, as well as sharing information between colleges, has been made simpler and faster, thanks to the Internet. There are pieces of visual history that could be viewed by only a few, but can now be downloaded by anyone who has access to the Internet. Children can tour the Louvre "through sixty panoramic views of the museum provided by QuickTime technology" without leaving their school (Louvre, 2001). Architects can also use the Internet to send digital pictures of excavation finds to labs hundreds of miles away within minutes of discovery and obscure

knowledge of historical acts can be found on the web. The ability to record and share historical information has become easier and more readily accessible to the masses thanks to the Internet.

For generation, the only way to learn about historical acts was to research them in books. Professional historians often had to travel miles to gain access to rare books in libraries. Students also had to rely on slow research through books in an effort to learn about acts of historical significance. The Internet changed all this by making large amounts of information available to anyone with Internet access. Large search engines like [www.dogpile.com](http://www.dogpile.com), which uses Altavista, Ask Jeeves, etc. can help students find the information they need quickly (Dogpile, 2002).

Access to visual historical objects has also increased due to Internet technology. Major museums can place all of their paintings, sculptures and other objects on a virtual tour that allows Internet users to view the object from more than just one angle. Many museums now offer similar virtual tours which allow visitors to “visit a virtual museum anytime and from anywhere and see their favorite things long enough without being anxious about other visitors crowding around them” (Kadobayashi, 2002, 212). Students who have never been out of urban neighborhoods in America can be exposed to Greek statues and Roman mosaics. Art and historically significant objects that were once difficult to access can now be viewed by those who might otherwise have never had the opportunity. Digital pictures of discovered artifacts can also be sent across the Internet to be analyzed. Delicate artifacts need not be shipped for other experts to analyze them when detailed digital pictures can be sent in minutes.

Government documents are also more easily available to the masses, thanks to the Internet. Historians can access documents without the hassle of waiting for copies of documents in the mail. Important speeches and legal documents with historical significance are all available through the Internet as are “federal public documents (including slide presentations made by officials)” (Cairncross, 1997, 260). The accessibility of official documents through the Internet and the ease and convenience it offers also increases the ability of those with an interest in genealogy to research their background. Historical documents and artifacts are becoming easily accessible to those who have an understanding of the Internet. Art Historians can find resources at numerous websites (e.g., [www.wisc.edu/](http://www.wisc.edu/)), which has compiled a database of art images and publications ranging from photographs to local artifacts in third world countries (Internet Resources for Art Historians, 2002).

The use of the Internet has changed the accessibility of historical knowledge as well as made it easier to teach history and to more efficiently store historical information. Information, which was once difficult to find, is now available at one’s fingertips. Teaching history in an interesting way with the use of the Internet is now possible as teachers take their students on virtual tours of museums. The use of the Internet has changed

the way we gather and share information, and in so doing has changed the way we view and record our history.

### 3.2 Science and the Internet

The Internet has given the field of science the opportunity to market itself in new ways. A broad range of science-based information is available on the Internet. Many tutorials are available for children who have difficulty with chemistry or physics while interesting sites also display fun scientific discoveries. Pictures from the Hubble satellite can be viewed online, as well as geological information about the earth’s atmosphere. Studies in environmental science are often posted online as many environmental activists have informative websites. The information is more easily available, and the ability to market this industry grows with the expansion of the Internet.

Professionals in the field of science can access the web to hunt for jobs and display their own research with ease. Many websites are focused on finding opportunities for those exclusively in the science field. Students can also access science information and use Internet tutor programs to help them advance in the field of science. There are numerous websites dedicated to assisting students like *Chemistryweb*, which is an “annotated directory of Internet resources for students, educators and researchers” (Lawal, 2000). Students from primary school to post-graduate college can utilize tutor programs provided by chemistry organizations online.

Major chemical businesses also utilize the Internet to market their products. Large oil companies, like Shell, show off their products online and encourage investors as they exhibit new uses for their products. Other major science based companies have interactive websites, which increase interest in their product while improving their image. Government based science programs also display Internet information as well as accept applications online. NASA’s website gives information about their location, launch dates, and offers information about applying for positions online (NASA, 2002, website).

The realm of environmental science on the Internet has also increased in the past few years. Interest in endangered species and the effects of pollution on the environment are just two reasons why the Internet has been used to display information concerning environmental science. Databases, which can be easily accessed and searched, hold large amounts of information concerning all aspects of the environment. Scientists interested in this field can find information quickly, and those interested in conservation of natural resources can also use these databases.

The Internet has made it easier for those in the field of science to share and gather information concerning many different areas of the Internet. This quick exchange of information and expanded resources make it important to be prepared for the high-tech environment. An understanding, coupled with an ability to fully utilize, the Internet will be a necessary task in the future for anyone planning to enter the field of science.

### 3.3 Criminal Justice and the Internet

In the field of criminal justice, the Internet represents an enormous challenge as well as a tool that can be utilized to educate and assist in crime prevention and solution. The use of the Internet has opened up entirely new avenues for criminals while providing them with anonymity. The challenge of tracking down criminals and prosecuting them on existing laws has become increasingly difficult for those in the criminal justice field. In order to prevent crime and prosecute criminals, knowledge of the Internet has become necessary for those entering the criminal justice field.

The Internet has allowed the criminal justice field to expand and become more easily accessible than ever before. Government websites provide full text documents that include previously difficult to obtain case transcripts. Lawyers are finding it easier to research for court cases due to the amount of information on the web that they can utilize.

Another aspect of the changes that the Internet has brought about in the criminal justice field is the entirely new avenue it has created for criminals to commit crimes. Criminals can invade the privacy of those who use the Internet and commit fraud that is difficult to trace in the physical world. Anyone with a computer can attempt to access the personal information that is stored in large databases on the Internet. Hackers can destroy large amounts of information online and are hard to detect. A Pentagon report stated, "a staggering 96 per cent of security breaches were found to have been detected" (Barrett, 1998, 40). Although they are protected by firewalls, credit card numbers from online purchases, banking information, and social security numbers are also accessible to hackers through the Internet. Child pornography rings have also become a crime perpetrated on the Internet. Criminals find the secrecy of the Internet the perfect medium to exploit children without exposing themselves unduly. These crimes are becoming more prevalent as the Internet grows, and those entering the criminal justice field will have to determine actions to control this behavior.

The new and faceless crimes on the Internet can be difficult to prosecute for several reasons. Existing laws often do not cover this relatively new medium, and the slow pace of passing legislation does not keep up with the lightning pace of the Internet. The international aspect of the crimes committed often-complicate matters considerably. For example, if a criminal in England steals American credit card numbers off of the Internet and uses them to make purchases in Japan, the issue of who has the right to punish the criminal comes into question. Fear of greater Internet crimes, like terrorism, is forcing those in the criminal justice to overview our current laws and pass new ones. The Patriot Act is an act that "permits federal investigators to use more-powerful tools to monitor phone calls, e-mail messages, and even Web surfing" (Kandra, 2002, 38). The changes in local laws may mean less privacy in order to achieve safety. Internet legislation varies widely from country to country

and those in the Criminal Justice field will be forced to deal with international issues when encountering the Internet due to its very nature of having no tangible geographic boundaries.

Those who plan to enter the Criminal Justice field will obviously be forced into dealing with the Internet. Those who neglect its research abilities will fall behind as more and more information concerning the Criminal Justice field becomes available online. The new opportunities available to criminals also make it imperative that those in this field have adequate knowledge of the Internet in order to discover and fight the crimes being committed on the Internet. The need for legislation that covers the criminal actions on the Internet and the international aspects on the Internet is also obvious. Anyone planning to enter the Criminal Justice field will obviously be left at a disadvantage without adequate knowledge of the Internet.

### 3.4 Business and the Internet

The Internet has also affected the diverse field of business tremendously. The Internet has opened up an entirely new way to run a business and market goods to the public. Obtaining consumer information is easier than ever thanks to the Internet. One-to-one marketing is feasible even for small and medium size businesses. Consumer convenience has increased due to this new medium as has acceptable product standards. Small and medium size businesses are able to compete with large multinational corporations. International trade and sales are increasing due to the ease, accessibility, and cost transparency created by the Internet. Studies show that "Large companies implementing Internet technologies already are realizing improvements of 13% to 21% in financial performance measures" and "small companies...can achieve even greater benefits" (Anderberg, 2001, 4). Anyone entering the business world in the future will surely encounter the Internet and experience the changes the Internet has brought about in the marketplace. The importance of a full comprehension of the power and effects of the Internet, as well as ability to use it to ones advantage, is necessary in today's market.

The Internet has allowed a new way of marketing products. Retailers can be removed in many instances as wholesalers and manufactures use websites to sell directly to their customers for minimum cost to the company (commonly referred to as dis-intermediation). Even small businesses can compete on an international level using the Internet if they have set up an appropriate infrastructure to handle their orders. The playing field has been leveled to a certain extent as small companies enter the market alongside business giants.

The importance of the Internet as an emerging and growing market cannot be ignored by business people. The Internet is a desirable marketplace since it is both measurable and sizeable. The Internet is certainly a growing market as "the rate of growth of Internet use in the United States is currently two million new internet users per month" (Anonymous, 2002, 4). Government

studies also show that “in September 2001, 143 million Americans were using the Internet – an increase of 26 million in 13 months”(Anonymous, 2002, 4). The number of global users is expected to almost double in the next two years, making the Internet market an increasingly desirable place to conduct business. An understanding of this growing market and the ability to compete in this new and expanding market will be a requirement for all who are entering business fields in the future.

Marketers can also gather information from this growing market with greater ease than ever before. Every click of the mouse that an Internet surfer makes can be monitored to discover their habits and preferences. Cookies, which are “digital markers automatically placed by websites in the hard disk of the computers that connect to them, so that internet sites like Amazon.com can keep track of their customer preferences and can design personalized sales techniques for each customer and market to them more efficiently” (Castelles, 2001, 171). Internet based marketing research is also popular and relatively inexpensive, thereby making it easy to obtain information from the consumer. The wealth of information makes it easier to market to each customer more efficiently.

The Internet does present several difficult issues that those in the business field must be aware of and be prepared to face. The global aspect of the Internet means that language and cultural barriers will almost certainly be encountered by anyone using this medium. The language of a website can effect its ability to be effective in an international market. Customers are three times more likely to buy a product off a site if the site is in their native tongue. If Internet entrepreneurs plan to be successful internationally, they must provide their site in multiple languages to appeal to all customers. The use of the Internet may vary from culture to culture as well. Some cultures prefer to interact in person and do not like to give out their credit card information, which makes it difficult to perform online transactions.

Business people must realize the difficulties presented when selling over the Internet, but even those who do not must confront the changes the Internet is making in the global society. Price transparency is becoming more prevalent all over the world as people in every country become aware of the prices that are being paid in other countries due to the Internet. Consumers in England are not willing to pay double the price of Americans when they can see the price difference on a website. International trade is changing due to the Internet, and those who neglect becoming involved may be left behind. Customers can find convenience and speed on the Internet through quick delivery. Even local retailers must compete with the Internet as any customer with a computer and Internet access can be lured away from the local market into the Internet market.

In the future business people may find it impossible to succeed without a full understanding and use of the Internet. Online banking and shopping are creating new ways to do business in the marketplace. The ease of

collecting consumer data is changing the way customers can be marketed to on the net and the ability to establish more one-to-one marketing situations. The very way that businesses interact internationally is changing as the Internet makes it easier and more productive to sell internationally than ever before. The incentive to fully understand the Internet and be prepared to tackle the barriers encountered in the Internet is great for anyone entering the business field. The Internet is quickly changing the way the world does business, and in order to keep up, an understanding of the Internet is required.

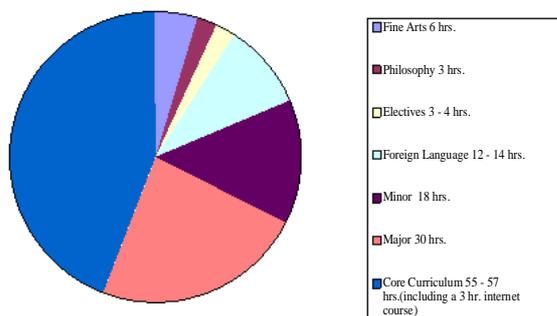
#### 4. Conclusion

In conclusion, the Internet has become a necessary tool for all disciplines today. The Internet is used by educators, business people, scientists, and historians alike. The Internet has changed the global market as well as the way we share information, communicate, and educate. The information available on the Internet is immense and it is important to be able to decipher the reliability and accuracy of all information collected.

It is therefore important that all students with hopes of entering professional fields have a complete understanding of the Internet and its uses. Currently there is not a comprehensive Internet course offered as a part of the core curriculum at Sam Houston State University, but the need for such a course is obvious. The use of the Internet continues to expand, and the opportunities that the Internet provides are vast. Every professional in the future will likely encounter the Internet and be able to enrich their professional experience through intelligent use of the Internet. The role of the Internet in society is only likely to increase, and anyone entering the workforce without a complete understanding of the Internet is entering with a disadvantage. Universities have a responsibility to prepare their students for the field that they choose to enter, and without providing courses that adequately cover the use of the Internet, universities are falling short in their responsibilities.

It will only benefit students to require a mandatory class, which will teach the basics of Internet practices. As the pie chart below illustrates, the addition of an “Introduction to the Internet” course in the core curriculum section of the degree plan will have little effect on the overall dispersal of hours. However, this class will provide students of every major the knowledge of current technology that is now necessary in order to succeed as a student and advance as a professional. By removing 3 hours from the electives category and adding them to the core curriculum minimal hour shifting is needed to achieve the hours required for an Internet course. Electives hours change from college to college while the core curriculum stays basically the same across the board. With these minor changes to the existing core curriculum, an important addition to the University learning process can be achieved.

**Bachelor's of Arts Degree with the Addition of Required Internet Course**



The information disseminated through an "Introduction to the Internet" course will benefit students immensely as they learn to research, create web sites, and decipher the reliability of information available to them over the Internet. Every student regardless of their discipline of study could benefit from such a class. The class would be taught in such a way as to provide the basics of Internet use without becoming too specific in any field of study.

The following syllabus is an example of one that may be used in an Introduction to the Internet course (see Appendix). The syllabus avoids being too "major" specific while being sure to cover the most important aspects of the Internet that effect students and professionals today. A short course schedule is included at the end of the syllabus and direction for the syllabus was taken from lesson plans on OnlineClassroom.com.

**5. Research Limitations**

Any research into a topic has limitations and the very nature of the Internet increases the likelihood of limitations. The Internet is constantly changing and expanding. The number of people using the Internet and the things that they use the Internet for are also constantly changing. This constant change makes all material gathered reliable for only a short period of time. When this paper is finished it will already be behind in its ability to relate the current status of the Internet.

It is extremely difficult to find up-to-date information about the Internet as a classroom focus. Since many resources on the use of the Internet are also found on the Internet, there is the issue of quality control. It can be difficult to choose material that is valid in the vast amount that is available on the Internet. Relying on print sources where the publisher has hopefully analyzed the material for quality control is tempting, but print materials quickly become outdated due to the time it takes to print them. Finding current materials that are of high quality can be complicated, and even the best research will quickly be outdated.

**6. Future Research**

Future research of this topic will be a requirement for anyone interested in the importance of educating college students in the use of the Internet. The quickly changing world of the Internet will make it important to have current material. A study of the newest resources and journals on the topic available on the Internet as well as the latest publications on the uses of the Internet will be helpful. Hundreds of new journals and books are published each year on the Internet and most are out of date within a year or two of their publication. Future research could also include field studies that were unable to be completed here due to time and resource constraints.

Research that reveals the number of Universities that offer a course that covers only the uses of the Internet, and how many of these courses are mandatory would be of use in determining the standards of other Universities concerning the Internet. Surveying students at Sam Houston could also be conducted at a future date and may prove very useful in establishing students' willingness to take such a course. Surveying students to discover how often they use the Internet and how comfortable they feel using it may help to establish a need for the class. Another survey of University professors may be of use in determining the need for such a class. Professors could be asked questions that determine how often they assign work that requires their students to use the Internet and how well they feel their students utilize the Internet.

A pilot study could even be conducted in which a sample of students would actually take the course in place of the current required computer course if they already feel skilled at basic computer knowledge. This group of students would be surveyed at the end of the course to determine if they found the course useful and if they felt that their Internet skills had improved their studies. At the same time, the group of students who completed only the computer class could complete a questionnaire to relate their feeling of competence on the Internet and ability to complete basic Internet functions, creating web pages and searching for quality information. After both groups are evaluated, their answers could be compared to determine if the current class adequately prepares students for Internet use or if an Introduction to the Internet class is needed.

Other research could also be based on the importance of Internet experience to agencies and corporations, which may hire from the Sam Houston State University pool. Is it important to these businesses that students be able to use the Internet with ease. Also, how many of these corporations allow or encourage telecommunication and what percentage of their employees telecommunicate? How many of these businesses hire employees from online applications and what percentage of their applications are online? These questions will help to reveal the importance of the Internet in the businesses that come into direct contact with Sam Houston State University students and regularly hire from the Institution.

Future research may also include creating a budget for such a class. Projecting a budget cost for starting an "Introduction to the Internet" class at Sam Houston State University and maintaining it. Will the computers and

Internet connections at the University be adequate to support a mandatory Internet class or will it be necessary to expand the computer materials now on campus? Will current computer fees from students cover this cost or will it be necessary to raise the cost of attending the University through increased Internet fees?

All future study into the uses of the Internet and the importance of the Internet to University students should be made as close to the date that the information is needed in order to ensure that the information is current. The ever-changing world of the Internet makes it important that future research is done when evaluating the subject. The importance of surveying students, professors, and businesses to determine the desire and need for an Internet class will be invaluable to those trying to reveal a need for such a course. Creating a projected budget is also invaluable in revealing whether such a class is possible at this time. The cost of such a class may outweigh the benefits of making it mandatory, and creating a budget for the course will reveal this. Regardless of the cost though, an Introduction to the Internet course is needed as the world changes and Internet skills become requirements in every profession.

## 7. Appendix

*Sam Houston State University  
Introduction to the Internet - Course Syllabus*

*Course Description:* This class will focus on the uses of the Internet and on gathering information on the Internet. Students will have hands-on experience in gathering information that is reliable and utilizing it to complete class projects. Every student will be responsible for creating their own website, creating links to other sites, using electronic mail and researching their subject online.

*Course Objectives:* To familiarize every student with the uses of the Internet. Make students comfortable with the research and quality control aspects of the Internet. Teach each student to create their own website and how to best utilize the Internet regardless of the field of study they plan to enter.

*Contents of Class:*

1. Surfing the Internet
2. Compare/contrast commercial and educational homepages
3. Set up e-mail; read, write, save e-mail and send attachments
4. Use Internet news resources; Register with a listserv/discussion group
5. Find answers to questions posed on your web-page topic
6. Compare/contrast search engines
7. Create and publish your own website

## Course Schedule

- Week 1:** Course Orientation. Introduction to class and review of syllabus. Internet basics and begin surfing the Internet.
- Week 2** Send and receive e-mail. Set-up e-mail account and send attachments. Complete exercises and e-mail attachments to professor. Cover e-mail privacy and dangers of viruses and spam.
- Week 3** Discussion Groups. Learn how to send and read e-mail from discussion groups.
- Week 4** Begin Electronic research. Learn how to use the Internet for research purposes.
- Week 5** Search Engines. Learn about different search engines and how to judge them.
- Week 6** Announce website topics and begin research for website using skills learned in class.
- Week 7** Learn how to judge material found on the Internet.
- Week 8** Website Construction. Learn how to develop web pages using information learned in class, Dreamweaver.
- Week 9** Learn how to create links to other websites and how to gauge the validity of the site to which you are creating a link.
- Week 10** Present websites in class and score the pages of other students for 10% of project grade.

## References

- [1] Anderberg, Ken. "E-Business, Not E-Commerce." Communications News Vol. 38 Issue 2, Feb 2001, 4.
- [2] Anonymous. "New Government Study of Internet Use Stirs Controversy." Distance Education Report No. 6, Mar 2002, 4.
- [3] Anonymous. "Internet Resources for Art Historians." Retrieved June 20, 2002. Available: <http://www.wisc.edu/arth/otherresources.html>.
- [4] Barrett, Neil. Digital Crime: Policing the Cybernation. London: Kogan Page Limited, 1997.
- [5] Beck, Beth. "NASA." Retrieved June 5, 2002. Available: <http://www.nasa.gov/>
- [6] Brandt, D. Scott. "Evaluating Information on the Internet." Retrieved June 15, 2002. Available: <http://thorplus.lib.purdue.edu/~techman/evaluate.htm>.
- [7] Cairncross, France. The Death of Distance: How the Communications Revolution Will Change Our Lives. Cambridge: Harvard Business UP, 1997.
- [8] Castelles, Manuel. The Internet Galaxy: Reflections on the Internet, Business, and Society. New York: Oxford UP, 2001.

- [9] CyberAtlas. "Nua Internet Resources." Feb. 22, 2002. Available: [http://www.nua.ie/surveys/index.cgi?f=VS&art\\_id=905357688&rel=true](http://www.nua.ie/surveys/index.cgi?f=VS&art_id=905357688&rel=true).
- [10] Flack, Chris. "A Literary Index: Marking Sense of Literature on the Internet." Retrieved June 20, 2002. Available: <http://www.vanderbilt.edu/AnS/english/flackcj/Litmain.html>.
- [11] Info Space, Inc. "Dogpile." Retrieved June 20, 2002. Available: <http://www.dogpile.com/>
- [12] Kadobayashi, Rieko, Yuya Iwakiri, and Kenji Mase. "Personalizing the Museum Exhibitions." Electronic Business and Education: Recent Advances in Internet Infrastructures. Boston: Kluwer Academic Publishers, 2002, 211-230.
- [13] Kandra, Anne. "National Security VS. Online Privacy: A New Antiterrorism Law Steps Up Electronic Surveillance of the Internet." PC World Vol. 20 Issue 1, Jan 2002, 37.
- [14] Kotabe, Masaaki, and Helsen, Kristiaan. Global Marketing Management. New York: John Wiley & Sons, Inc., 2001.
- [15] Lawal, Michael. "Chemisrtyweb." Retrieved June 5, 2002. Available: <http://www.ssc.ntu.edu.sg:8000/chemweb/htmlj/>
- [16] Louvre. "Louvre Museum Virtual Tour." Retrieved June 10, 2002. Available: <http://www.Louvre.fr.louvrea.htm>
- [17] Murray, Janet R. "Information TeAchnology: Using the Internet for Student Research." Electronic Business and Education: Recent Advances in Internet Infrastructure. Boston: Kluwer Academic Publishers, 2002. 15-32.
- [18] Parent Education Network. "Disability Resource Website Links." Retrieved June 15, 2002. Available: <http://www.parentednet.org/disablereaources.html>.
- [19] PenguinPutman, Inc. "Penguin Putman Homepage." Retrieved June 20, 2002. Available <http://www.penguinputnam.com/>
- [20] Rifkin, Jeremy. The Age of Access. New York: Penguin Putnam Inc., 2000.
- [21] Schneider, Karen G. "Librarians' Index to the Internet." Retrieved June 20, 2002. Available: <http://lii.org/>
- [22] Thirteen/WNET New York. PBS. "Thirteen ed Online." Retrieved June 20, 2002. Available: <http://www.thirteen.org/wnetschool>.
- [23] TBT International, Inc. "OnlineClass" Retrieved June 15, 2002. Available: <http://www.OnlineClass.com>
- [24] University of Phoenix. "University of Phoenix Online." Retrieved June 15, 2002. Available: <http://onl.uophx.edu/degrees.html>.
- [25] Woolf, Beverly Park, Victor Lessor, Chris Eliot, Zachary Eyley-Walker, and Mark Klein. "A Digital Marketplace for Education." Electronic Business and Education: Recent Advances in Internet Infrastructures. Boston: Kluwer Academic Publishers, 2002. 1-14.

# Considerations for Computer Ownership Policies

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## Abstract

The introduction of Internet technology is changing the way people communicate, work and live. In business environments, individuals are using electronic networks instead of the traditional methods to accomplish their goals. Furthermore, as more industries implement new applications of technology, the pressure on employees and consumers to acquire new skills increases. The result is an urgent need for higher learning institutions to adopt computer and technology protocols that leverage network resources to deliver on demand services. As an option, institutions are turning to the capabilities of wireless technology to create wireless network campuses. Although it appears to be an ideal solution, both the challenges and the opportunities require careful consideration.

## 1. Introduction

On a national level, academic institutions, recognizing the demand for graduates capable of succeeding in a technology driven economy, are developing and implementing computer ownership policies and standards. Currently, California State Polytechnic University of Pomona is considering the development of a notebook requirement for undergraduate e-business students in the College of Business Administration. The question then becomes what type of computer ownership program or policy to implement. Should students be required to own a desktop computer or a notebook computer, similar to the University of Florida policy? Should academic institutions offer a recommendation only, such as that offered by University of Indiana? To answer these questions, various issues must be explored.

There are various issues to consider when developing computer ownership standards and policies, for example, student demand, faculty willingness to incorporate new tools into existing curriculum, and what is the availability of technology and resources. For example, are the students willing to accept the use of new technology to facilitate learning when the current methods have previously been successful? Would students from other degree programs accept a computer or notebook requirement? Another, item to consider, involves the current and expected use of wireless technology? These are just a few of the questions that require careful attention when considering implementing a computer

ownership policy. The following takes a closer look into the struggle of one university to provide quality education in an ever-changing environment. Lastly, similar policies currently implemented at other institutions, such as the University of Florida, University of Indiana, and Georgia Tech University, serve as a comparison model for California State Polytechnic University of Pomona to develop their own computer policy.

## 2. California State Polytechnic University of Pomona seeks to establish Policy

California State Polytechnic University of Pomona is constantly anticipating the demands of the economy. The College of Business Administration is especially interested in changes in business practices. In the fall of 2001, Cal Poly, Pomona launched a new concentration within the Bachelor of Science in Business Administration. The E-business Concentration developed in response to today's evolving business environment, which demands graduates be equipped with a thorough understanding of e-business theory and practice.

The E-business Concentration (EBZ) is responsive to the markets' increasing emphasis on the use of technology related skills. In addition to technical skills, the field of e-business requires that professionals be equipped with interpersonal abilities. To support the development of these skills, students work in teams with an extensive emphasis on group collaboration. The College of Business Administration practices a "learn by doing" approach to management education, which encourages the support and development of programs that facilitate the learning process.

In keeping with this philosophy, Dean Eduardo Ochoa of the College of Business Administration sought to utilize available resources in technology to facilitate learning. In particular, Ochoa saw the usage of notebook computers as a viable tool to accomplish the objectives of CBA and the EBZ Concentration. Courses in the curriculum involve a structure based on team collaboration. Therefore, a notebook computer is an excellent tool because it offers mobility and the ability to access learning anytime and anywhere.

## 3. Earlier Notebook Requirement for Cal Poly, Pomona's MBA/MSBA Program

Currently, the College of Business Administration at Cal Poly, Pomona has a laptop requirement for their MBA/MSBA program. However, the laptop requirement policy encountered unexpected obstacles once implemented. The initial proposal overlooked how the new requirement would be incorporated into the curriculum. The CBA faced an enormous dilemma because, at the time, the majority of the Faculty lacked sufficient computer and Internet knowledge to incorporate such a requirement into existing curriculum. In addition, there was little incentive for the faculty to incorporate the use of notebooks in their course outlines.

Soon, the MBA/MSBA students expressed resentment towards the requirement. Their primary complaint revolved around the fact that Instructors were not incorporating the use of the notebooks in the classroom. To address this issue, in the summer of 2001, Ochoa, "provided faculty with the opportunity to apply for support to develop innovative and creative ways to incorporate an instructionally relevant component of their classes, which would use the notebooks in a meaningful way (McLaughland, 2001)." Of the proposals submitted, 5 stipends were approved and implemented during the following quarter.

#### 4. Gathering Support for Notebook Requirement Policy

New policies or initiatives typically involve gathering feedback from those affected most. When Georgia Institute of Technology began their student computer policy implementation in 1995, the President G. Wayne Clough appointed a Student Computer Ownership Committee ("STUDENT COMPUTER OWNERSHIP," 2002). The committee brought together students, faculty, and staff, to study the various trends and attitudes toward a proposal to require computer ownership of all enrolled students. Once the review process was finalized, a student computer ownership policy was recommended by Georgia Tech faculty requiring all students with the class of 2002 to have their own computer.

In keeping with a similar concept, Cal Poly of Pomona and the College of Business Administration initiates the process by incorporating student and faculty feedback. Due to a lack of enthusiasm from both the faculty and the MBA/MSBA students, there are additional feelings of apprehensive about implementing such a program for undergraduate students, without sufficient evidence of both student and faculty support. As a result, during winter term 2002, Dean Ochoa suggests to first determine how receptive EBZ students are of a notebook requirement.

In February 2002, the E-Business Society, a professional student organization, initiates to assist the CBA with the notebook requirement project, by

conducting a survey. Dr. Robert Schaffer, Professor of International Business and Marketing and E-Business Society, Faculty Advisor, and John Tang, E-Business Society member, develop a questionnaire to administer to a sample size of approximately 200 students enrolled in EBZ courses. The survey objective is to determine the attitudes and level of cooperation from Cal Poly E-business students to a laptop requirement. Secondly, the survey gathers the student perspective on purchasing options. The results of the survey, supports the hypothesis that E-business students favor having a laptop requirement.

See exhibit 1 and 2.

#### 5. Available Resources: Hardware Requirements

The results from the survey show sufficient evidence to conclude Cal Poly of Pomona undergraduate students are supportive of a notebook requirement. The following recommended step is to establish minimum configuration standards for hardware and software. The E-Business Society collaborates with students in the EBZ program to compile a list of the minimum specifications required of the e-business concentration, utilizing informal email surveys. Prior to completion of this list, the Society sought input from Richard Van Lommel, Senior System Administrator Consultant for the College of Business Administration of Cal Poly, Pomona. Van Lommel plays a significant role because of his involvement in implementing the notebook requirement for the MBA/MSBA program (Personal communication, August 9, 2002). After careful evaluation, he recommended for the minimum configuration to be offered as a baseline standard and provide the more robust configuration model as the recommend configuration. (See exhibit 3).

#### 6. Wireless Access

Wireless access is available to students, in building 6, on the Cal Poly, Pomona campus. To connect to the network students will require a computing device capable of using a wireless adapter card and a wireless adapter that supports the IEEE 802.11b standard. Previously, the University was undecided on which wireless card brand to use (L. Turner, personal communication, July 17, 2002). There were issues of security and concerns with longevity of Cisco cards. In a recent development, the concerns and issues were resolved and the decision to use Cisco is confirmed (R. Van Lommel, personal communication, August 9, 2002). The Cisco Aironet 350 wireless client adapter (AIR-PCM352), is available through the Bronco Bookstore for \$120.00. Although there are also older 340 series adapters available and possibility available at a lower price, the newer cards have a higher power output capability and more advanced performance features.

## 7. Evaluation of Other Computer/Notebook Policies

Cal Poly of Pomona is committed to the professional development of its' students. A portion of the research complies samples to better understand what was meant. I Part of the process evaluate various other models of existing standards. The following are the current computer/notebook policies and recommendations for Indiana University and Florida University. They serve as an example of different ways to implement such policies within the College of Business Administration.

### 7.1 Case 1 Indiana University, Kelley School of Business

<http://www.bus.indiana.edu/ugrad/compinfo.html>

The University of Indiana currently does not require undergraduate students within the Kelley School of Business to own a computer. However, they recognize that various undergraduate programs in the Kelley School of Business expect to incorporate the use of networked (wired/plug-in) classrooms over the next three to four years. In addition to the use of wired/plug-in classrooms, all undergraduate dormitories are wired for network connectivity.

The University of Indiana considers a computer to be a wise investment. Although, notebooks provide mobility and may connect to the UI network from various academic buildings, the Kelley School of Business encourages undergraduate students to consider purchasing the less convenient and less expensive hardware choice. Their recommendation is for students to purchase a decent desktop system for no more than \$1,500. The University, also, provides suggested minimum hardware guidelines in order to use all the technology services available at IU. (See exhibit 4) To accommodate their recommendation, the University has negotiated various pricing plans with numerous vendors. Students have access to the vendor links from the IU website. The vendors include Apple, Dell, Gateway and the IU Bookstore. For an example of a recommended laptop configuration, (see exhibit 5).

### 7.2 Case Study 2: University of Florida, Warrington College of Business

<http://www.cba.ufl.edu/programs/computer.asp>

The University of Florida has an official policy on the student computer requirement. Their policy stipulates beginning summer term 1998 all junior level and new incoming students must purchase computer hardware and software appropriate to his or her degree program. Students may not graduate unless computer proficiency is demonstrated. The policy continues with the expectation that all students will purchase or lease a computer capable of accessing the Internet, through dial up or network

connections, and posses' productivity programs for spreadsheets and various calculations.

The University provides the minimum computer configurations for all students. (See Exhibit 6). Individual colleges may have additional requirements or recommendations for lower division, upper division, graduate and professional students.

The Warrington College of Business stipulates that all junior, senior and master level students must have a notebook computer. For an example of these requirements, see exhibit 7. The College of Business has also established negotiated prices from Dell and IBM. The links are available online.

## 8. Available Models for California State Polytechnic University of Pomona

The decision to implement a computer/notebook policy or standard is relatively difficult because there are numerous models available. However, with student support, wireless network standard established, as well as vendor support, the decision is less complex.

The first option for Cal Poly Pomona is to delay implementation of any computer standard/policy. One benefit to the University is in cost savings, in the event a new technology for wireless networks is developed, making the existing infrastructure obsolete. The drawback to the University is the loss in revenue due to lower enrollment. Students will prefer to attend other universities because they offer innovative programs demanded by the market.

The second option available to Cal Poly, Pomona is to approve a minimum configuration standard to offer as a recommendation only for students. The policy resembles the policy adopted by Indiana University. The university benefits because it will be perceived by others an innovative campus with extensive knowledge of the inner workings of technology. In addition, the campus will benefit with a slight increase in enrollment once the policy is added to the CBA web site. Furthermore, students will appreciate the opportunity to access the current negotiated discounts available to all faculty, staff and students within the California State University System. However, since this model is offered as a recommendation, the drawback for students requiring financial assistance is that financial aid is not offered.

The third option available is a model similar to the University of Florida, Warrington College of Business. The College of Business offers a recommendation only for hardware and software configurations to all concentrations. The Cal Poly Pomona policy would offer a notebook requirement to junior and senior level EBZ students. However, the College may offer to extend the requirement to CIS students since their use of computing

tools is extensive and would also benefit from these policies. If a laptop requirement is implemented, those students in financial need will have access to financial aid monies. Furthermore, the College of Business will benefit from an increase in enrollment as a result of the laptop requirement.

The fourth option available to Cal Poly, Pomona is a model similar to the California State University of Bakersfield. Their model offers information resources information as a means to increase the knowledge and understanding of the students. The University Web site provides recommendations for both PC and Mac computers. Students may purchase software at students' prices from the information resource page.

## 9. Conclusion

The status of Cal Poly of Pomona's Notebook Initiative is currently undergoing further consideration. The objective is to take all possible scenarios into account before imposing such a costly requirement upon the students. Although careful consideration is recommended, each day that passes without a computer/notebook policy

implemented, is a disservice to the students. Students are at a disadvantage when they do not receive the skills, nor the education demand by the new Internet technology enabled economy.

## References

[1]Equipment Standards Policyand Purchasing Recommendations (August 13, 2002) Retrieved July 19, 2002, from The CSUB Information Resources, Web Site: <http://www.csusak.edu/infores/Standards/hardware/>

[2]Mclaughland, E., 2001. The Directors Message [online]. California State Polytechnic University, Pomona. Available from: <http://www.csupomona.edu/%7Emba/enewsletter/Fall%202001/index.html> [Accessed 15 August 2002]

[3]STUDENT COMPUTER OWNERSHIP INITIATIVE (February 2002) Retrieved August 9, 2002, from The Georgia Institute of Technology, Office of Enrollment Services, Web site: <http://www.sco.gatech.edu/downloads/sco2002.doc>

## Appendix

### Exhibit 1 Survey Questionnaire Excerpt

#### E-Business Society

The E-Business Society is collecting data so that we might make recommendations to the college administration concerning the possibility of either requiring or encouraging EBZ majors to have laptop computers. Thank you for your time in completing this survey.

1. What is your Major? \_\_\_\_\_  
 What is your Career \_\_\_\_\_  
 Track within this major? \_\_\_\_\_
2. Gender
  - Female
  - Male
3. Approximately, what is your annual household income?
  - 0-\$10,000
  - \$10,001-\$20,000
  - \$20,001-\$30,000
  - \$30,001+
4. On average, how often do you check your e-mail?
  - Continuously (DSL, LAN or network connection)
  - 3-4 times
  - At least once
  - Perhaps once every 2-3 days
  - Once a week or less
5. Excluding e-mails, about how many hours each week, on average, do you spend on line?  
 \_\_\_\_\_ hrs/week

Thank you for your time.

## Exhibit 2 Excerpt from Results of the Survey

### E-Business Laptop Survey

#### Background

**Management Decision Problem:** E-business graduates are going to enter a high technology job environment. In order to succeed in an environment such as this and meet the necessary challenges E-business graduates will need to have all the necessary tools, giving them the best opportunity for success.

**Research Objectives:** To determine the attitudes and level of cooperation from Cal Poly E-Business students to a possible laptop requirement. As well as attitudes toward laptop purchasing options.

**Hypotheses:** The majority of e-business students will show more favoritism toward a laptop requirement. E-Business students are using computers and the Internet a great deal in their classes and surely will see the need to become better acquainted with hardware and software tools.

**Significance of the Study:** This study will show that students are serious about the need for technology in their education. It will also show teachers the importance of implementing these technologies into the educational process. Corporations may also find through this survey that Cal Poly students have a high level of technical proficiency and a great desire to maintain and increase that through their education. Laptop vendors will also find that Cal Poly students will respond to the laptop requirement with full cooperation.

**Information Needs:** The following information was taken for this study:

Major	Amount of time on the internet
Gender	Current computer
Income	Importance of PC
Frequency of E-mail usage	Pricing
Monthly payment Requirement	Financial Aid
	Payment options

#### Descriptive Results

Question 1: What is your major?

		MAJOR			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	49	24.5	24.5	24.5
	2.00	26	13.0	13.0	37.5
	3.00	50	25.0	25.0	62.5
	4.00	18	9.0	9.0	71.5
	5.00	37	18.5	18.5	90.0
	6.00	6	3.0	3.0	93.0
	8.00	3	1.5	1.5	94.5
	9.00	1	.5	.5	95.0
	10.00	1	.5	.5	95.5
	11.00	1	.5	.5	96.0
	14.00	4	2.0	2.0	98.0
	15.00	2	1.0	1.0	99.0
	16.00	1	.5	.5	99.5
	17.00	1	.5	.5	100.0
	<b>Total</b>	200	100.0	100.0	

Question 2: Gender

		GENDER			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	82	41.0	41.0	41.0
	2.00	118	59.0	59.0	100.0
	<b>Total</b>	200	100.0	100.0	

Question 3: Approximately, what is your annual household income?

INCOME					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	53	26.5	26.5	26.5
	2.00	36	18.0	18.0	44.5
	3.00	23	11.5	11.5	56.0
	4.00	88	44.0	44.0	100.0
	Total	200	100.0	100.0	

Question 4: On average, how many times do you check your e-mail?

TIMES					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	73	36.5	36.5	36.5
	2.00	62	31.0	31.0	67.5
	3.00	43	21.5	21.5	89.0
	4.00	19	9.5	9.5	98.5
	5.00	3	1.5	1.5	100.0
	Total	200	100.0	100.0	

Question 6: What type of computer do you currently own?

COMPTYPE					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	134	67.0	67.0	67.0
	2.00	9	4.5	4.5	71.5
	3.00	49	24.5	24.5	96.0
	4.00	8	4.0	4.0	100.0
	Total	200	100.0	100.0	

Question 7: Do you feel it is important to have your own personal computer?

Importance of PC					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	4.00	6	3.0	3.0	3.0
	5.00	11	5.5	5.5	8.5
	6.00	21	10.5	10.5	19.0
	7.00	162	81.0	81.0	100.0
	Total	200	100.0	100.0	

Questions 8: Notebooks are available from many different sources, with many features, at several prices. Considering the features that you want, about how much will that computer cost?

PRICE					
		Frequency	Percent	Valid Percent	Cumulative Percent

	50.00	1	.5	.5	.5
	100.00	3	1.5	1.5	2.0
	200.00	6	3.0	3.0	5.0
	400.00	2	1.0	1.0	6.0
	500.00	6	3.0	3.0	9.0
	600.00	3	1.5	1.5	10.5
	700.00	2	1.0	1.0	11.5
	800.00	3	1.5	1.5	13.0
	900.00	7	3.5	3.5	16.5
	999.00	1	.5	.5	17.0
	1000.00	20	10.0	10.0	27.0
	1099.00	1	.5	.5	27.5
	1100.00	2	1.0	1.0	28.5
	1200.00	18	9.0	9.0	37.5
	1300.00	8	4.0	4.0	41.5
Valid	1400.00	7	3.5	3.5	45.0
	1500.00	32	16.0	16.0	61.0
	1599.00	1	.5	.5	61.5
	1600.00	2	1.0	1.0	62.5
	1700.00	7	3.5	3.5	66.0
	1800.00	3	1.5	1.5	67.5
	1900.00	2	1.0	1.0	68.5
	2000.00	39	19.5	19.5	88.0
	2200.00	1	.5	.5	88.5
	2400.00	2	1.0	1.0	89.5
	2500.00	10	5.0	5.0	94.5
	2800.00	1	.5	.5	95.0
	3000.00	8	4.0	4.0	99.0
	3500.00	1	.5	.5	99.5
	7000.00	1	.5	.5	100.0
	Total	200	100.0	100.0	

Question 9: Considering the computer you envisioned above, about what monthly payment would you expect to make?

MONTHLY					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	9	4.5	4.5	4.5
	6.00	1	.5	.5	5.0
	8.00	1	.5	.5	5.5
	10.00	6	3.0	3.0	8.5
	15.00	3	1.5	1.5	10.1
	20.00	9	4.5	4.5	14.6
	25.00	10	5.0	5.0	19.6
	30.00	12	6.0	6.0	25.6

	35.00	4	2.0	2.0	27.6
	40.00	4	2.0	2.0	29.6
	45.00	2	1.0	1.0	30.7
	50.00	46	23.0	23.1	53.8
	60.00	5	2.5	2.5	56.3
	70.00	4	2.0	2.0	58.3
	75.00	4	2.0	2.0	60.3
	80.00	3	1.5	1.5	61.8
	100.00	45	22.5	22.6	84.4
	125.00	1	.5	.5	84.9
	150.00	14	7.0	7.0	92.0
	200.00	10	5.0	5.0	97.0
	300.00	4	2.0	2.0	99.0
	500.00	1	.5	.5	99.5
	750.00	1	.5	.5	100.0
	Total	199	99.5	100.0	
Missing System		1	.5		
Total		200	100.0		

Question 10: Would you be interested in applying for financial aid funding towards the purchase of a notebook computer?

Financial Aid Funding					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	41	20.5	20.5	20.5
	2.00	5	2.5	2.5	23.0
	3.00	6	3.0	3.0	26.0
	4.00	19	9.5	9.5	35.5
	5.00	17	8.5	8.5	44.0
	6.00	7	3.5	3.5	47.5
	7.00	105	52.5	52.5	100.0
	Total	200	100.0	100.0	

Question 11: Assuming that the college provides a variety of payment options, do you feel it is reasonable to require all business students to have a notebook computer?

Laptop Requirement					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	26	13.0	13.0	13.0
	2.00	12	6.0	6.0	19.0
	3.00	23	11.5	11.5	30.5
	4.00	24	12.0	12.0	42.5
	5.00	24	12.0	12.0	54.5
	6.00	27	13.5	13.5	68.0
	7.00	64	32.0	32.0	100.0
	Total	200	100.0	100.0	

Results with respects to relationships

ANOVA was used to determine if there were any significant relationships between variables. All the relationships at .10 or greater are presented below.

Frequency that student checks their e-mails:

- Students that frequently check their emails were more likely to feel that it is important to have their own computers. (sig.= .03)
- Students that frequently check their e-mails are not as price sensitive to laptops as students that don't check their e-mails as frequent. (sig.=.061)
- Students that check their e-mails frequently are more favorable towards having a laptop requirement. (sig.=.001)

Types of computers students own:

- Students that own laptops are more favorable towards having a laptop requirement. (sig.=.058)

Majors:

- EBZ and MHR students are more likely to feel that it is important to have their own computers. (sig.=.071)
- EBZ and Marketing students are more favorable of having a laptop requirement. (sig.=.000)
- EBZ students are more likely to check their e-mails than other four majors. (sig.=.018)

Gender:

- Females are more likely to pay higher monthly payments on their laptops. (sig.=.026)
- Males are more favorable toward having a laptop requirement. (sig.= .075)

Income:

- Females are more likely to check their e-mails more frequent than do males. (sig.=.073)
- Students that have higher incomes are more likely to consider personal computers to be important. (sig.=.048)

Conclusion

The conclusion supports the hypothesis of E-business students being more favorable towards having a laptop requirement. We can infer that E-business students are different in some ways, and one those ways are, they are more likely to support and accept the laptop requirement. E-Business students are more likely to appreciate and support a laptop requirement. E-business students see the need for laptops in their education, and in the event of a laptop requirement, E-business students will be more willing to support this initiative.

**Exhibit 3 Minimum Requirements**

**Laptop Requirements**

Hardware Standards:

In order for students to complete their degree programs successfully, on-going use of a computer is required. The specifications listed as baseline are the minimum standards that all notebook computers should meet.

Students are encouraged to upgrade or purchase a notebook computer to meet or exceed the recommended specifications. The principle behind the recommended specifications is that these laptops will be usable for three years from the date of purchase.

Baseline (Minimum)/ Recommended Laptop Requirements:

	Baseline	Recommended
<u>CPU</u>	Pentium III,1.1 GHz Processor (Celeron/ AMD is ok)	Pentium 4, 1.6 GHz Processor or higher, (AMD is ok)
<u>Memory</u>	128MB SDRAM	256MB SDRAM
<u>Screen</u>	14.1" Viewable, capable resolution 1024x768 or higher	14.1" Viewable, capable resolution 1024x768 or higher
<u>Hard Drive</u>	20 Gig HD	30 Gig HD

Modem	Integrated 56k Fax/Modem v.92	Integrated 56k Fax/Modem v.92
Network Card	Integrated 10/100 NIC	Wireless PCMCIA card (CISCO Aironet 350) available at bookstore \$120 (optional)
Multimedia	32MB DDR nVidia GeForce4 AGP 4X Graphics Integrated CD-ROM Drive Integrated Sound Card	64MB DDR nVidia GeForce4 AGP 4X Graphics Integrated DVD - CD-RW Combo Drive Integrated Sound Card
Software	Windows 98/ME, NT, 2000, XP Microsoft Office 2000, XP (standard) Option of no software	Windows 98/ME, NT, 2000, XP Microsoft Office 2000, XP (Pro) Option of no software
Other Misc. Items	Built-in floppy drive Lithium Ion-Battery 2 USB Ports, 1 Serial Video output Carrying case Weights 8lbs or less Warranty Plan (1 year std)	Built-in floppy drive Lithium Ion-Battery 2 USB Ports, 1 Serial Video output Carrying case Weights 8lbs or less Warranty Plan (3 year optional)

#### Exhibit 4 Indiana University, New Computer Hardware Recommendations

<http://computerguide.indiana.edu/buying/index.html>

In order to use all the technology services available at IU, we suggest the following minimum hardware components if you are purchasing a new computer.

	<u>Minimum PC Requirements</u>		<u>Minimum Mac Requirements</u>
Processor:	1.2GHz or higher	Processor:	500MHz PowerPC G3
Memory (RAM):	256 MB SDRAM	Memory (RAM):	128 MB SDRAM
Hard Drive:	20 GB Ultra ATA hard drive	Hard Drive:	20 GB Ultra ATA hard drive
Video Card:	Direct-X compatible video card with 32 MB Video RAM	Video Card:	Not Applicable
Sound Card:	SoundBlaster compatible sound capability with two speakers	Sound Card:	Not Applicable
CD-ROM:	48x DVD/CD-ROM drive (or 16x CD-R/W)	CD-ROM:	48x DVD/CD-ROM drive (or 16x CD-R/W)
Removable Storage Media:	Internal Floppy, Internal Zip250 Zip Drive	Removable Storage Media:	Internal Floppy, Internal Zip250 Zip Drive
Ports:	2 USB ports	Ports:	2 USB & Fire Wire ports
Operating System:	Windows XP Professional	Operating System:	Mac OS 9.2.2 or OS X (Requires 128 MB RAM)

## Exhibit 5 Indiana University Negotiated Computer deals

<http://computerguide.indiana.edu/index.html>

Laptop Sample from Dell: Dell latitude C610 (Laptop)

Price \$ 1632.00

S&H \$35.00

Total: \$1667.00

IU Students, faculty, and staff can order Dell systems online, or by phone at 1-888-987-3355. When ordering by phone, don't forget that you must identify yourself as being affiliated with Indiana University.

Component	Description	Dell SKU
Base Unit:	Pentium III, 1.0Ghz, 14.1" XGA Display, NIC	220-9503
Memory:	256MB SDRAM, 1 DIMM	311-2034
Video Card:	ATI Mobility RADEON 16MB DDR SDRAM	
Floppy Drive:	3.5" 1.44MB Floppy Drive	
Hard Drive:	20GB Hard Drive, 9.5 MM	340-7943
Operating System:	Windows 2000, Service Pack 2	420-2315
Network Card:	Internal True mobile 1150 Mini-PCI Wireless Network Card	430-0902
Modem:	Internal 56K V.92 Modem	313-5205
CD-ROM:	24X CD-ROM, Internal/External	313-0249
Speakers:	Integrated stereo speakers	
Service:	Type 3 Contract - Next Business Day Parts & Labor On-Site Response Initial Year	900-6550
Service:	Type 3 Contract - Next Business Day Parts & Labor On-Site Response 2YR Extended	900-6232

## Exhibit 6 University of Florida, Sample computer configurations for University

<http://www.circa.ufl.edu/computers/>

For students acquiring a computer in spring through fall 2002, the following are recommended minimum configurations. These minimum specifications are not necessarily available in new computer configurations currently on the market and are provided as a reference for a minimally configured computer. Some colleges have specific requirements more restrictive than the general campus recommendation; see the [college requirements](#) section below for more details.

- 300 MHz or faster CPU (e.g., Intel Pentium/Celeron family, AMD K6/Athlon/Duron family, or compatible processor)
- 64MB or more RAM for Windows 98, NT, or Me operating systems, 128MB or more for Windows 2000, and 256MB or more for Windows XP operating systems is recommended. For other operating systems and software applications, check the minimum requirements of the operating system and application software you will be using for the necessary RAM for your needs.
- 4 GB or larger hard drive
- 10x or faster CD-ROM drive
- High-resolution graphics adapter with at least 2 MB video RAM, supporting at least 24-bit color at 800 X 600 resolution. Laptops should have an external monitor port for connection to an external monitor or classroom projection system.
- High-resolution color display (at least 800 X 600 resolution, 24-bit color. Laptop displays should be at least 12" diagonally, and use active-matrix technology. Desktop displays should be at least 15" diagonally.)
- Sound support, including speakers or headphones
- 56kbps V.90 modem (avoid any modem labeled "win modem" or "modem for Windows")
- Laptops should have PCMCIA or PC-Card slots
- A high-quality printer (ink-jet or laser) is recommended, although limited printing facilities are available in campus labs.
- Bundled software should include either Corel or Microsoft office suite.<sup>1</sup>

<sup>1</sup>The office application suites come in several varieties and combinations of programs. You should evaluate your choice of office productivity suite based on the needs of your intended coursework. Word processing and spreadsheet applications are used in almost all disciplines. Presentation applications are highly recommended since they are used in many courses and many fields. Database applications may be needed in some disciplines. Remember that you can always add the missing applications later, if you discover an unforeseen need.

## EXHIBIT 7 University of Florida, Warrington College of Business Computer Requirement for Masters and Undergraduate Students

<http://www.cba.ufl.edu/programs/computer.asp>

Junior / Senior / Masters (Enrolling Summer 2002 through Spring 2003)

If you do not own a notebook computer meeting the following standards, upgrade or buy a notebook computer to meet or exceed the following minimum standards:

### Hardware Specs:

- 500 MHz processor
- 10 gigabyte hard drive
- 256 megabytes or more of RAM
- 10X CD ROM with sound support including speakers and/or headphones
- Lithium Ion battery
- A 10/100 Network adapter (for Ethernet and/or cable modem access)
- 56Kbps V.90 Modem (for dial-up access)

### Software Specs:

- Windows 2000 OR XP - Professional Edition (Millennium Edition and XP Home Edition is not recommended nor supported.) Compare the features - <http://www.microsoft.com/windows/>
- Microsoft Office 2000 OR XP Professional with Access. Microsoft Office 2000 Small Business Edition (SBE) bundled with many computers is not adequate. It lacks PowerPoint and Access. Microsoft Office Premium Edition is an acceptable and superior alternative as it includes all the features of Professional plus FrontPage and PhotoDraw - <http://www.microsoft.com/office/>
- Microsoft Internet Explorer - <http://www.microsoft.com/windows/ie/>
- Microsoft Outlook Express - <http://www.microsoft.com/windows/oe/>

# An Empirical Study of the Impact of IT Intensity and Organizational Absorptive Capacity on Customer Relationship Management Performance

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## Abstract

In recent years, e-Business has emerged as a mainstream business practice. Engaged in highly-competitive Internet-enabled markets, many business organizations have turned to customer relationship management (CRM), a computer-based information system that allows them to gain greater insight into their customers' needs, to gain a competitive advantage. Consequently, CRM has risen to become a key e-business issue. Yet, many critical organizational factors underlie the success and performance of CRM. This study examines the impact of information technology (IT) intensity and organizational absorptive capacity on CRM practices and performance, and presents a research model. Data collected through a survey of Taiwan financial service institutions suggest that CRM practices mediate the effects of IT intensity and organizational absorptive capacity on CRM performance.

## 1. Introduction

As more businesses transition to e-business, competition in the Internet-enabled marketplace becomes keener. Many have turned to information technology (IT) for solutions that provide a competitive advantage. One such IT-based solution that has gained popularity in recent years is customer relationship management (CRM), frequently defined as an information system to assist the customer retention process or a methodology that extensively employs information technology (IT), particularly database and Internet technologies, to enhance the effectiveness of relationship marketing practices. Generally, greater investments in IT provide CRM with greater capabilities. As a formidable strategic weapon, CRM tunes the organization into listening to its customers, and allows it (organization) to develop customized products and services that cannot be easily duplicated, substituted or imitated by their competitors, and consequently more precisely fit their needs [29], [30], [34], [39]. Given this context, the primary objectives of CRM involve attracting, developing and maintaining successful customer relationships over time [2], [6], and building customer loyalty [20] through efficient and

effective two-way dialogues [39]. As the customer-business relationship flourishes, both the customers and organization benefit [40].

An important factor that may critically affect CRM performance lies in the organization's ability to leverage and exploit its knowledge toward innovating new products and services. Past studies [4], [5], [16] suggest that an organization's ability to link its knowledge to its innovativeness (i.e., ability to innovate) depends upon its absorptive capacity, the ability to recognize and assimilate new information, and apply the ensuing knowledge to commercial ends (i.e., exploitation) [5]. Therefore, differences in CRM practices and performance may be attributed to differences in absorptive capacity. Greater investments in developing organizational learning may lead to more successful results of CRM.

The purpose of this paper is to examine the effects of IT intensity, an organization's commitment to its IT infrastructure and IT applications, and organizational absorptive capacity on CRM practices and performance. This study proposes that organizations with stronger IT intensity and greater absorptive capacity will reap greater benefits from CRM, and be inclined to develop and produce more innovative products and services for their customers and as a result deepen their relationships. Hence, IT intensity and absorptive capacity should affect the CRM practices (i.e., customer insight) and CRM performance (i.e., organization and customer benefits). This study expands upon earlier research that examined the relationship between organizational absorptive capacity and CRM performance, and seeks to conceptually and empirically validate the relationship through a review of supporting studies and survey data collected from Taiwanese financial institutions, respectively.

## 2. The Impact of IT Intensity on Marketing Practices and Customer Services

Because CRM is an IT-enabled system, its performance hinges on the resources and investments an organization commits to it. IT intensity refers to the IT infrastructure and applications that allow the organization to benefit from its IT investments and apply them toward their best interests. The

infrastructure ensures access to and the availability of computing resources (i.e., hardware, software, data), and facilitates information sharing and communication throughout the organization. Henderson and Venkatraman [13] suggest that an organization's IT infrastructure has two components: (1) a technical IT infrastructure, and (2) a human IT infrastructure. Duncan [10] sees the technical IT infrastructure as a set of tangible, shared, physical IT resources that form a foundation for various business applications. Tangible IT resources include hardware and operating systems, network and telecommunications technologies, data, and core software applications.

In contrast, the human IT infrastructure addresses the necessary individual skills and knowledge required to develop, maintain, manipulate and support end-users in their abilities to leverage the technical infrastructure. Osterman [28] discusses the importance of developing and acquiring individual skills and roles to enable an organization's investments in IT. Without an adequate human IT infrastructure, the organization will realize very little benefit from its IT infrastructure and investments. In essence, the human IT infrastructure must shadow the development of a technical IT infrastructure.

With increasing emphasis being placed on organizational IT, the impact of IT on marketing practices and customer services has become more apparent over the past several years. As a major driving force, IT has permitted organizations to introduce continual improvements to their marketing practices in their quest to secure competitive advantages. These improvements fall into two general categories: (1) marketing process automation and (2) marketing intelligence. While marketing process automation helps link marketing activities to facilitate information sharing (i.e., efficiencies), marketing intelligence aims to enhance decision making through tools that provide greater insights. In many cases, the continual advances in IT have led to more sophisticated applications of IT. For example, the results of a survey conducted by Stone and Good [37] on computerization aids in the assimilation of tactical and strategic marketing activities strongly indicate that marketers are applying IT in new ventures, including tactical and strategic marketing activities such as the application of EDI to strategic supply chain [24]. Li et al. [23] found that many marketers are becoming more familiar with information and Internet technologies, and actively engaging in the development of computer applications that meet their specific information needs. The impact of IT on marketing practices has been an enabler of greater efficiencies (i.e., faster responses to satisfy information needs) and market intelligence.

IT also opens many new business opportunities in the customization of products and services, and development of customer loyalty. In particular, the migration of many businesses from traditional *bricks and mortar* operations to e-business has refocused the market's competitive orientation from product-centric to

customer-centric. Thus, the emphasis now lies in understanding each customer's needs in contrast to targeting a group or market segment with similar needs. In their discussion of IT enhancement to customer service, Walsh and Godfrey [38] suggest that e-tailers hold greater opportunities to offer better customer service than their *bricks and mortar* counterparts through customization, and add greater value to their products and services through personalized sites.

Along with the ability to gain greater insights into their customers' needs, organizations also now possess the capability to leverage their knowledge toward developing customer loyalty. Past studies reveal that the greatest leverage comes from investments in the retention rather than the generation of new customers [35], [32], [36], [39]. In their examination of e-loyalty and the unique economics of e-business customer loyalty, Reichheld and Scheffer [34] state that building loyalty involves first gaining the customer's trust, and not the application of technology and the Internet. Even though the Internet is a powerful tool for strengthening relationships, the basic laws and rewards of building loyalty have not changed. A study of Karimi et al. [19] that gauged IT management practices to determine whether they differed among firms seeking a competitive advantage with IT when it was linked to their customer service lends further support to this. The proposed relationship between customer value and positions on the product and process structure of Heim and Sinha [12] also reflects the value of developing customer loyalty.

### 3. Organizational Absorptive Capacity

Another organization factor with significant influence on CRM performance is organizational absorptive capacity. The absorptive capacity of an organization results from the cumulative learning activities of its individuals and the transfer of knowledge within the organization through a common language [5]. Learning activities occur with new experiences directed toward exploration (i.e., research), routine experiences and training. These activities help develop knowledge that can be used to recognize, acquire, assimilate and apply new knowledge. The more frequent learning occurs, the greater the accumulation process, which in turn reinforces prior knowledge, increases the capacity to retain new knowledge and yields the application of knowledge to new scenarios [3]. Thus, continuous learning builds over time a repository of knowledge that allows the organization to recognize and solve new problems with innovative solutions. The knowledge structures resulting from learning form a wealth of knowledge that eventually becomes available to the entire organization as a shared resource.

Absorption capacity allows organizations to leverage this knowledge (i.e., recognize and assimilate new information, and apply knowledge) in the form of innovative responses to benefit from their insights

garnered through their customer relationships. The greater the knowledge possessed and shared throughout the organization, the more the organization will be inclined to *absorb* new knowledge, and apply it toward innovative, creative and effective products and services. Thus, leveraging becomes greater as knowledge becomes pervasive in the organization.

## 4. CRM Practices: Market Orientation and Customer Service

### 4.1 Market Orientation

Various issues of market orientation have been widely discussed since the 1990s, including performance implications [17], [21], [25], [26], [27], measurement [7], [14], [22], and antecedents and performance outcomes [17], [27]. Market orientation can be defined as the organization-wide generation, dissemination and responsiveness to market intelligence, and involves information sharing among multiple departments engaged in activities directed toward meeting customer needs. In contrast to product-driven marketing, which focuses on pushing end products into markets while promoting lower prices and good quality, market-orientation concentrates on detecting customer needs and quickly fulfilling them. Market -orientation practices have positive impacts on an organization's performance and new products, and promote customer-centric values.

### 4.2 Customization and Loyalty Programs

The objective of customization is to provide tailor-made products/services that appeal to and more precisely fit the individual customer's needs. This requires soliciting customers for their feedback and integrating this information into production processes such that it provides the organization with its greatest competitive advantage [31]. However, customization incurs costs, and sacrifices flexibility and speed [8]. Mass customization attempts to customize products and services for the individual customers to reach a one-to-one marketing level. It can be seen as an extension of traditional product differentiation which strives toward changing the product's characteristics to competitively distinguish it from another business' offering. In contrast, mass customization achieves differentiation through targeting the product's or service's benefits toward satisfying the customer's specific needs. The advances in IT makes mass customization more feasible as it allows individual customer behavior to be traced and analyzed through data warehouses and data mining techniques, all of which make customer service easier and solution-oriented [18].

Through the analysis of their collected data, organizations can capitalize on future opportunities through the development of loyal programs. Loyalty programs behoove organizations to develop since they often lead to increases in repeat-purchase rates and

usage frequency, and raise barriers of entry into the market by making it difficult for new entrants to court customers away from existing businesses [36]. The market research studies of Hughes [15], and Reichheld and Sasser [33] strongly suggest that loyalty programs can increase business revenue and total customer market share. Similarly, Dowling and Uncles [9] conclude that loyalty programs can introduce many benefits to their promoters.

## 5. Research Model and Test of Hypotheses

Figure 1 illustrates this study's research model. The model proposes the impact of IT intensity and organizational absorptive capacity on CRM practices and performance. IT intensity and organizational absorptive capacity represent the independent variables, while CRM practices a mediator variable, and CRM performance represented by business benefits and customer benefits the two dependent variables. Based on a review of the literature, previous related case studies and field experiences shared by industrial experts, the following hypotheses and sub-hypotheses are presented:

- H1: There is a positive relation between IT intensity and CRM practices
  - H1a: There is a positive relation between IT intensity and market orientation
  - H1b: There is a positive relation between IT intensity and customer service
- H2: There is a positive relation between absorptive capacity and CRM practices.
  - H2a: There is a positive relation between absorptive capacity and market orientation.
  - H2b: There is a positive relation between absorptive capacity and customer service
- H3: There is a positive relation between CRM practices and CRM performance.
  - H3a: There is a positive relation between market orientation and firm benefits.
  - H3b: There is a positive relation between market orientation and customer benefits.
  - H3c: There is a positive relation between customer service and firm benefits.
  - H3d: There is a positive relation between customer service and customer benefits.
- H4: There is a mediating effect of market orientation on IT intensity, absorptive capacity to CRM performance.
  - H4a: There is a mediating effect of market orientation on IT intensity, absorptive capacity to firm benefits.
  - H4b: There is a mediating effect of market orientation on IT intensity, absorptive capacity to customer benefits.

H5: There is a mediating effect of customer service on IT intensity, absorptive capacity to CRM performance.

H5a: There is a mediating effect of customer service on IT intensity, absorptive capacity to firm benefits.

H5b: There is a mediating effect of customer service on IT intensity, absorptive capacity to customer benefits.

## 6. Research Methodology

### 6.1 Data Collection and Sample

Survey questionnaires with accompanying cover letters were mailed to 542 Taiwanese financial service companies. The cover letter briefly explained the purpose of this research project, which received funding from the National Science Council (NSC) of Taiwan, and contained general instructions for completing the survey. The recipients were restricted to CRM and marketing managers, and customer service department heads. Two weeks after the initial mailing, 99 responses were received. Follow-up telephone calls were made a week later, urging non-response recipients to complete and return their surveys by either mail or fax. In total, 173 responses were returned for a response rate of 30 percent. Among the returned surveys, nine were incomplete and discarded; this reduced the sample size to 164. The final sample covers a broad cross-section of firms in the banking, insurance and trading industries as well as many others.

### 6.2 Measures

A standard psychometric scale development procedure [11] was followed to generate multiple-item scales based on a review of the literature and interviews with IT and marketing professionals. Measures with single- and multiple-item formats and conceptualized multiple-items scales as formative or reflective in nature were formulated. The questionnaire was pre-tested and refined following the comments of the IT and marketing managers. All items were operationalized using five-point Likert-type scales. Table 1 provides the operational definitions of each variable. Table 2 contains the results of the reliability test while Table 3 shows the summary statistics of all constructs and the variance-covariance matrix.

A comparison between respondents and the population on four variables (number of employees, capital, industries, and age of the firm) was conducted to examine the data for potential non-response bias. None of these four t-tests for differences between the sample and the population means was statistically significant at a 0.05 level. Moreover, no significant differences between earlier and later respondents on the scores of each question item were detected. The absence of differences supports the contention that no response bias is present in the sample [1].

## 7. Results

Eight hierarchical regression models were developed to test the hypotheses. Firm capital (CAPITAL) and the number of employee (EMPLOYEE) were set as the control variables. Tables 4 through 11 provide summaries of the statistical results. The p-values for IT-intensity (IT\_NESS) and absorptive capacity (ABSRPTVE) (Tables 4 and 5) both indicate significance ( $p < .01$ ). The VIF values show no sign of colinearity. The first model (Table 4) suggests that IT intensity and organizational absorptive capacity are positively related to market orientation (MK\_ORNT), one of the elements of CRM practices. Therefore, H1a and H2a are supported. The second model (Table 5) also suggests that IT-intensity and absorptive capacity are positively related to customer service (CS), the second element of CRM practices, and thereby lends support to H1b and H2b.

The regression models shown in Tables 6 and 7 suggest that the relationships between customer service (CS) and firm benefits (F\_BENEFI, Table 6), and customer service and customer benefits (C\_BENEFI, Table 7) are both significant ( $p < 0.01$ ) and positive, and support H3c and H3d. Market orientation practice is also positively related to firm benefits (Table 6,  $p < .01$ ) and customer benefits (Table 7,  $p < .05$ ). Therefore, both H3a and H3b are supported. The VIF values indicate the presence of no collinearity.

Several regression models were developed to test the mediating effects of CRM practices (market orientation and customer service). The results are summarized in Tables 8 through 13. Tables 8 and 9 reveal that both absorptive capacity and IT intensity have direct effects on CRM performance ( $p < .01$  and  $.05$ , respectively) as measured against customer and firm benefits. When market orientation is included (Tables 10 and 12), the models suggest market orientation's mediating effect on customer benefits (market orientation,  $p < .01$ ; IT-intensity,  $p > .05$ ; absorptive capacity,  $p > .05$ ), and a partial mediating effect on firm benefits (market orientation,  $p < .05$ ; IT-intensity,  $p > .05$ ; absorptive capacity,  $p < .05$ ). Partial mediating effects were also found between customer service and firm (customer service,  $p < .01$ ; IT-intensity,  $p > .05$ ; absorptive capacity,  $p < .05$ ) benefits (Table 11), but a mediating effect between customer service and customer benefits (customer service,  $p < .01$ ; IT-intensity,  $p > .05$ ; absorptive capacity,  $p > .05$ ) (Tables 13). The models support H4b and H5b, but not H4a and H5a due to the partial mediating effects.

## 8. Conclusion

This paper investigated the impact of IT intensity and absorptive capacity on CRM practices and CRM performance, and the mediating effects of CRM practices. Based on the data collected through a survey of financial institutions in Taiwan, the analyses indicate that (1) IT intensity and absorptive capacity are

positively related to CRM practices (i.e., firm benefits, customer benefits), and (2) CRM practices (i.e., market orientation, customer service) are positively related to CRM performance. Furthermore, (3) CRM practices can be treated as mediators since they can influence the impact of IT intensity and organizational absorptive capacity on CRM performance.

Adopting CRM has been a top priority for many business organizations. To ensure a successful CRM implementation, the results of this study suggest that organizations need to enhance their IT intensity, such as investing in their IT infrastructure, and improving and fully utilizing their IT applications. More importantly, they need to develop their absorptive capacity through

enhanced training programs and knowledge transfer capabilities. Nevertheless, improving IT intensity and enlarging absorptive capacity are important for all organizations engaged in e-business and CRM. Organizations that maintain a market-oriented strategy, adopt customization approaches and place greater emphasis on customer service will promote customer benefits and eventually retain their customers and increase revenue and profits.

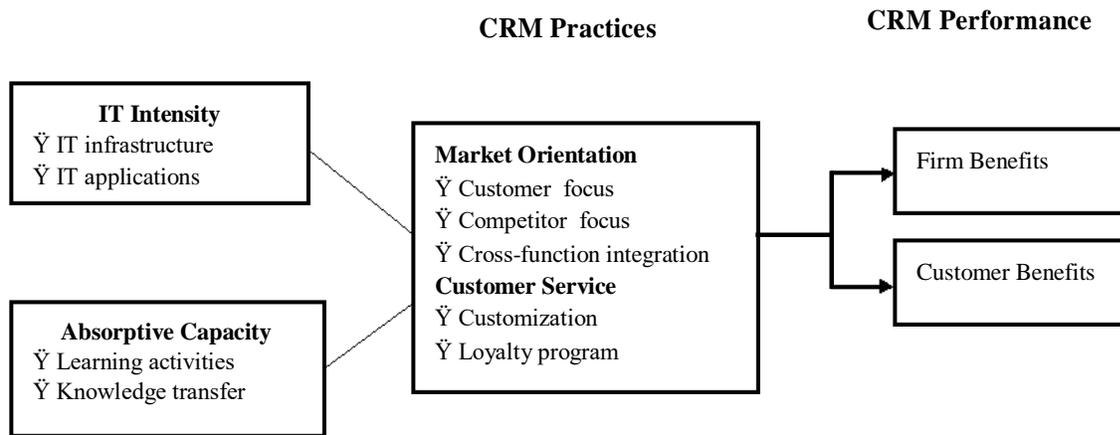


Figure 1. Research model

Table 1. Operational definitions

Variables	Operational definition	References
<b>IT intensity</b>	IT infrastructure IT applications	Sacha ( 1996 ) ; Michael ( 1996 ) , Kalakota & Whinston( 1996)
<b>Absorptive capacity</b>	Individuals cumulative learning activities Organization knowledge transfer Management climate	Cohen and Levinthal (1990); Boynton et al. (1994); Bower and Hilgrad (1981); Massey et al. (2001)
<b>Market orientation</b>	Customer focus Competitor focus Cross functional integration	Narver & Slates (1990); Han et al.( 1998 ) ; Slater and Narver( 2000)
<b>Customer service</b>	Customization Loyalty program	Customized services Customized capability Marketing campaigns Customer profitability Strategic alliance
<b>CRM performance</b>		
Firm benefits	Profit increase, Cost down, New opportunities	Storey and Easigwood ( 1999 ) ; Swift ( 2001 ) ; Winer( 2001)
Customer benefits	Social benefits, Psychological benefits, Economic benefits, Customized benefits	Gwinner et al. (1998)

**Table 2. Reliability test**

Cronbach alpha = .9625

Dimensions	Coefficients
Absorptive capacity	0.9255
IT intensity	0.9152
Market orientation	0.9081
Customer service	0.7821
Firm benefits	0.8987
Customer benefits	0.9305

**Table 3. Mean, standard deviation, and correlations between variables**

	Mean	S.D.	1	2	3	4	5	6
1. Absorptive capacity	3.1715	0.7243	1.000					
2. IT intensity	3.7936	0.7022	0.528**	1.000				
3 Market orientation	4.0027	0.5993	0.502**	0.587**	1.000			
4. Customer service	3.5015	0.6706	0.465**	0.513**	0.598**	1.000		
5. Firm Benefits	3.8486	0.6044	0.384**	0.351**	0.376**	0.440**	1.000	
6. Customer Benefits	4.0071	0.6074	0.347**	0.325**	0.399**	0.417**	0.814**	1.000

\*\* correlation is significant at the .01 level

**Table 4. Regression analysis result for H1a and H2a**

**Coefficients<sup>a</sup>**

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	4.097	.098		41.856	.000		
	CAPITAL	-3.21E-02	.040	-.107	-.801	.424	.348	2.878
	EMPLOYEE	6.339E-03	.056	.015	.114	.910	.348	2.878
2	(Constant)	1.968	.214		9.211	.000		
	CAPITAL	-1.96E-02	.031	-.065	-.637	.525	.346	2.889
	EMPLOYEE	-4.74E-02	.043	-.113	-1.096	.275	.341	2.933
	IT_NESS	.399	.061	.468	6.513	.000	.706	1.417
	ABSRPTVE	.222	.059	.268	3.768	.000	.721	1.387

a. Dependent Variable: MK\_ORNT

**Table 5. Regression analysis result for H1b and H2b**

**Coefficients<sup>a</sup>**

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	3.497	.110		31.874	.000		
	CAPITAL	-2.38E-02	.045	-.071	-.529	.597	.348	2.878
	EMPLOYEE	3.442E-02	.062	.074	.551	.583	.348	2.878
2	(Constant)	1.424	.259		5.492	.000		
	CAPITAL	-1.25E-02	.037	-.037	-.335	.738	.346	2.889
	EMPLOYEE	-1.61E-02	.052	-.034	-.306	.760	.341	2.933
	IT_NESS	.359	.074	.378	4.839	.000	.706	1.417
	ABSRPTVE	.250	.071	.271	3.499	.001	.721	1.387

a. Dependent Variable: CS

**Table 6.** Regression analysis result for H3a and H3c

**Coefficients<sup>a</sup>**

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	3.765	.098		38.303	.000		
	CAPITAL	-2.89E-02	.040	-.096	-.717	.474	.345	2.902
	EMPLOYEE	7.683E-02	.056	.184	1.377	.170	.345	2.902
2	(Constant)	1.977	.307		6.431	.000		
	CAPITAL	-1.51E-02	.036	-.050	-.420	.675	.343	2.915
	EMPLOYEE	6.175E-02	.050	.148	1.239	.217	.343	2.911
	MK_ORNT	.188	.088	.187	2.134	.034	.635	1.574
	C S	.292	.079	.324	3.705	.000	.639	1.566

a. Dependent Variable: F\_BENEFI

**Table 7.** Regression analysis result for H3b and H3d

**Coefficients<sup>a</sup>**

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	3.975	.099		40.053	.000		
	CAPITAL	-2.55E-02	.041	-.084	-.627	.531	.345	2.902
	EMPLOYEE	5.068E-02	.056	.121	.900	.370	.345	2.902
2	(Constant)	2.128	.312		6.829	.000		
	CAPITAL	-1.11E-02	.037	-.037	-.305	.761	.343	2.915
	EMPLOYEE	3.686E-02	.051	.088	.730	.467	.343	2.911
	MK_ORNT	.242	.089	.239	2.709	.007	.635	1.574
	C S	.245	.080	.271	3.077	.002	.639	1.566

a. Dependent Variable: C\_BENEFI

**Table 8.** Regression analysis result for testing mediating effects (I)

**Coefficients<sup>a</sup>**

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	3.757	.098		38.231	.000		
	CAPITAL	-3.06E-02	.040	-.101	-.759	.449	.348	2.878
	EMPLOYEE	8.498E-02	.056	.202	1.519	.131	.348	2.878
2	(Constant)	2.435	.256		9.522	.000		
	CAPITAL	-2.52E-02	.037	-.083	-.683	.496	.346	2.889
	EMPLOYEE	5.656E-02	.052	.134	1.094	.276	.341	2.933
	IT_NESS	.170	.073	.198	2.321	.022	.706	1.417
	ABSRPTVE	.229	.070	.274	3.249	.001	.721	1.387

a. Dependent Variable: F\_BENEFI

**Table 9.** Regression analysis result for testing mediating effects (II)

**Coefficients<sup>a</sup>**

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	3.973	.100		39.835	.000		
	CAPITAL	-2.60E-02	.041	-.085	-.637	.525	.348	2.878
	EMPLOYEE	5.312E-02	.057	.125	.935	.351	.348	2.878
2	(Constant)	2.730	.264		10.352	.000		
	CAPITAL	-2.07E-02	.038	-.068	-.544	.587	.346	2.889
	EMPLOYEE	2.582E-02	.053	.061	.484	.629	.341	2.933
	IT_NESS	.169	.076	.195	2.237	.027	.706	1.417
	ABSRPTVE	.205	.073	.243	2.817	.005	.721	1.387

a. Dependent Variable: C\_BENEFI

**Table 10.** Regression analysis result for testing mediating effects (III)

**Coefficients<sup>a</sup>**

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	3.757	.098		38.231	.000		
	CAPITAL	-3.06E-02	.040	-.101	-.759	.449	.348	2.878
	EMPLOYEE	8.498E-02	.056	.202	1.519	.131	.348	2.878
2	(Constant)	1.973	.312		6.325	.000		
	CAPITAL	-2.06E-02	.036	-.068	-.566	.572	.345	2.896
	EMPLOYEE	6.770E-02	.051	.161	1.326	.187	.338	2.956
	IT_NESS	7.633E-02	.081	.089	.941	.348	.556	1.797
	ABSRPTVE	.177	.072	.212	2.443	.016	.661	1.512
	MK_ORNT	.235	.094	.233	2.510	.013	.577	1.734

a. Dependent Variable: F\_BENEFI

**Table 11.** Regression analysis result for testing mediating effects (IV)

**Coefficients<sup>a</sup>**

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	3.757	.098		38.231	.000		
	CAPITAL	-3.06E-02	.040	-.101	-.759	.449	.348	2.878
	EMPLOYEE	8.498E-02	.056	.202	1.519	.131	.348	2.878
2	(Constant)	2.018	.267		7.547	.000		
	CAPITAL	-2.15E-02	.035	-.071	-.609	.544	.346	2.891
	EMPLOYEE	6.128E-02	.050	.146	1.237	.218	.341	2.935
	IT_NESS	6.459E-02	.075	.075	.859	.392	.615	1.627
	ABSRPTVE	.155	.070	.187	2.221	.028	.669	1.495
	C.S	.293	.075	.325	3.905	.000	.681	1.469

a. Dependent Variable: F\_BENEFI

**Table 12.** Regression analysis result for testing mediating effects (V)

		Coefficients <sup>a</sup>				Collinearity Statistics		
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Tolerance	VIF
		B	Std. Error	Beta				
1	(Constant)	3.973	.100		39.835	.000		
	CAPITAL	-2.60E-02	.041	-.085	-.637	.525	.348	2.878
	EMPLOYEE	5.312E-02	.057	.125	.935	.351	.348	2.878
2	(Constant)	2.160	.319		6.775	.000		
	CAPITAL	-1.50E-02	.037	-.049	-.404	.686	.345	2.896
	EMPLOYEE	3.953E-02	.052	.093	.757	.450	.338	2.956
	IT_NESS	5.355E-02	.083	.062	.646	.520	.556	1.797
	ABSRPTVE	.140	.074	.167	1.899	.059	.661	1.512
	MK_ORNT	.290	.096	.285	3.023	.003	.577	1.734

a. Dependent Variable: C\_BENEFI

**Table 13.** Regression analysis result for testing mediating effects (VI)

		Coefficients <sup>a</sup>				Collinearity Statistics		
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Tolerance	VIF
		B	Std. Error	Beta				
1	(Constant)	3.973	.100		39.835	.000		
	CAPITAL	-2.60E-02	.041	-.085	-.637	.525	.348	2.878
	EMPLOYEE	5.312E-02	.057	.125	.935	.351	.348	2.878
2	(Constant)	2.336	.278		8.409	.000		
	CAPITAL	-1.73E-02	.037	-.056	-.469	.639	.346	2.891
	EMPLOYEE	3.026E-02	.052	.071	.587	.558	.341	2.935
	IT_NESS	6.959E-02	.078	.080	.891	.374	.615	1.627
	ABSRPTVE	.136	.073	.161	1.862	.064	.669	1.495
	C S	.276	.078	.304	3.539	.001	.681	1.469

a. Dependent Variable: C\_BENEFI

## References

- [1] Armstrong and Overton (1997). Estimating non-response bias in mail surveys. *Journal of Marketing Research*, 14, 396-402.
- [2] Berry, L. L and Parasuraman, A. (1991). *Marketing Service: Competing Through Quality*. New York: The Free Press.
- [3] Bower, G.H., and Hilgrad, E.R. (1981). *Theories of learning*. Englewood Cliffs, NJ: Prentice-Hall.
- [4] Boynton, A.C., Zmud, R.W., and Jacobs, G.C. (1994). The influence of IT management practice on IT use in large organizations. *MIS Quarterly*, 18, 299-318.
- [5] Cohen, W.M., and Levinthal, D. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly*, 35, 128-152.
- [6] Day, G.S. (2000). Managing marketing relationships. *Journal of the Academy of Marketing Science*, 28, 24-31.
- [7] Deshpande, R., and Farley, J.U. (1998). Measuring market orientation: Generalization and synthesis. *Journal of Market Focused Management*, 2, 213-232.
- [8] Dewan R., Jing, B., and Seidmann, A. (2000). Adoption of internet-based product customization and pricing strategies. *Journal of Management Information Systems*, 17, 9-28.
- [9] Dowling, G. R. and Uncles, M. (1997). Do customer loyalty programs really work? *Sloan Management Review*, Summer, 71-88.
- [10] Duncan, N.B. (1995). Capturing flexibility of information technology infrastructure: A study of resource characteristics and their measure. *Journal of Management Information Systems*, 12, 37-57.
- [11] Gerbing, D.W., and Anderson, J.C. (1988). An updated paradigm for scale development incorporating unidimensionality and its assessment. *Journal of Marketing Research*, 25, 186-192
- [12] Heim, G.R., and Sinha, K.K. (2001). A product-process matrix for electronic B2C operations: Implications for the delivery of customer value. *Journal of Service Research*, 3, 286-299.
- [13] Henderson, J.C., and Venkatraman, N. (1994). Strategic alignment: A model for organizational transformation via information technology. In Allen, T.J., & Morton, M.S.S. (Eds.), *Information technology and the corporation of the 1990's*. Oxford, UK: Oxford University Press, 202-220.
- [14] Homburg, C., and Pflesser, C. (2000). A multiple-layer model of market-oriented organizational culture: measurement issues and performance outcomes. *Journal of Marketing Research*, 37, 449-462.
- [15] Hughes, A. M. (2001). Strategic database marketing: The master plan for starting and managing a profitable,

- customer-based marketing program. New York, NY: McGraw-Hill.
- [16] Hurley, R.F., and Hult, G.T.M. (1998). Innovation, market orientation, and organizational learning: An integration and empirical examination. *Journal of Marketing*, 62, 42-54.
- [17] Jaworski, B. J., and Kohli, A. (1993). Market Orientation: Antecedents and Consequences. *Journal of Marketing*, 57, 53-71.
- [18] Kalakota, R. and Robinson, M. (2001). *e-Business: Roadmap for success*. Reading, MA: Addison-Wesley.
- [19] Karimi, J., Somers, T.M., and Gupta, Y. (2001). Impact of information technology management practices on customer service. *Journal of Management Information Systems*, 17, 125-158.
- [20] Kohli, R., Piontek, F., Ellington, T., VanOsdol, T., Shepard, M., and Brazel, G. (2001). Managing customer relationships through e-business decision support applications: A case of hospital-physician collaboration. *Decision Support Systems*, 32, 171-187.
- [21] Kohli, A., and Jaworski, B. J. (1990). Market orientation: The construct, research propositions, and managerial implication. *Journal of Marketing*, 54, 1-18.
- [22] Koli, A., Jaworski, B.J., and Kumar, A. (1993). MARKOR: A measure of market orientation. *Journal of Marketing Research*, 30, 467-77.
- [23] Li, E.Y., McLeod, R., Jr., and Rogers, J.C. (2001). Marketing information systems in fortune 500 companies: A longitudinal analysis of 1980, 1990, 2000. *Information & Management*, 38, 307-322.
- [24] Lim, D., and Palvia, P.C. (2001). EDI in strategic supply chain: impact on customer service. *International Journal of Information Management*, 21, 193-211.
- [25] Matsuno, K., and Mentzer, J.T. (2000). The effects of strategy type on the market orientation-performance relationship. *Journal of Marketing*, 64, 1-16.
- [26] Moorman, C., and Rust, R.T. (1999). The role of marketing. *Journal of Marketing*, 63, 180-197.
- [27] Narver, J. C. and Slater, S. F. (1990). The Effect of a Market Orientation on Business Profitability. *Journal of Marketing*, 54, 20-35.
- [28] Osterman, P. (1995). Impact of IT on jobs and skill. In M. Scott Morton (Ed.), *The Corporations of the 1990s*. New York, NY: Oxford University Press.
- [29] Peppard, J. (2000). Customer relationship management (CRM) in financial services. *European Management Journal*, 18, 312-327.
- [30] Peppers, D., Rogers, M., and Dorf, R. (1999). *The one-to-one fieldbook*. New York, NY: Currency and Doubleday.
- [31] Pitta, D.A. (1998). Marketing one-to-one and its dependence on knowledge discovery in databases. *Journal of Consumer Marketing*, 15, 468-480.
- [32] Reichheld, F.F. (1996). *The loyalty effect*. Boston, MA: Harvard Press.
- [33] Reichheld, F.F., and Sasser, Jr., W.E. (1990). Zero defections: Quality comes to services. *Harvard Business Review*, September-October, 105-111.
- [34] Reichheld, F.F., and Scheffer, P. (2000). E-Loyalty: Your secret weapon on the web. *Harvard Business Review*, 78 (4), pp. 105-113.
- [35] Ryals, L., and Knox, S. (2001). Cross-functional issues in the implementation of relationship marketing through customer relationship management. *European Management Journal*, 19, 534-542.
- [36] Sharp, B., and Sharp, A. (1997). Loyalty programs and their impact on repeat-purchase loyalty patterns. *International Journal of Research Marketing*, 14, 473-486.
- [37] Stone, R.W., and Good, D.J. (2001). The assimilation of computer-aided marketing activities. *Information & Management*, 38, 437-447.
- [38] Walsh J., and Godfrey, S. (2000). The Internet: A new era in customer service. *European Management Journal*, 18, 85-92.
- [39] Winer, R.S. (2001). A framework for customer relationship management. *California Management Review*, 43, 89-105.
- [40] Yim, C.K., and Kannan, P.K. (1999). Consumer behavior loyalty: A segmentation model and analysis. *Journal of Business Research*, 44, 75-92.

## Implement Innovative Proactive-Service-Center to Enhance Service Performance in Customer Site

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### Abstract

How to more efficiently and effectively enhance service performance is an on-going challenge to any service team. A new service model, Proactive-Service-Center (P-S-C), is developed since Feb'01. As a result, the service performance results are improved in terms of same day issue closure rate, issue response time and system uptime. The P-S-C is not only an innovative way to enhance service performance but also a systematic way to build-up engineers' trouble-shooting capability.

In the old service situation, the information flows randomly among customer engineers, customer section managers, AMT engineers, and AMT site managers. The average time spent is around two hours from Issue Happened to Dedicated Engineer on site. Customer and AMT engineers are running around like a chicken without head. The information flows inefficiently and ineffectively among customer engineers, section managers, AMT engineers and site managers. The detailed solutions are not documented and remained in the engineers' heads.

In the PSC model, the information flows automatically from the system which is down to the customer Server then to the PSC Server and the dedicated AMT engineer is automatically informed. The information flows efficiently and effectively. The actions

done are then systematically entered and documented in PSC and a monthly analysis report is generated and provided to customers.

The cost savings of PSC can be estimated indirectly. The issue response time is reduced from 2 hours to 58 minutes (reduced by 62 minutes). This translates to the increase of system uptime by 62 minutes. This will bring cost savings. In addition, the issue closure rate is improved from 50% to 85% (improved by 35%). This also translates to the increase of system uptime. The system uptime enhancement is cost savings.

Three areas which need improvement are identified to be Technology, People and Process. Technology: Internet is used and many auto functions (for example, reminding, reporting) are built-in to enhance the capability. People: Dedicated Engineer Matrix is built-in PSC and the right engineer can be reached at the right time in the most efficient manner. Process: Process is real time and systematic with clear R&R defined to ensure efficiency and experience build-up in the future.

Data : Original work performed

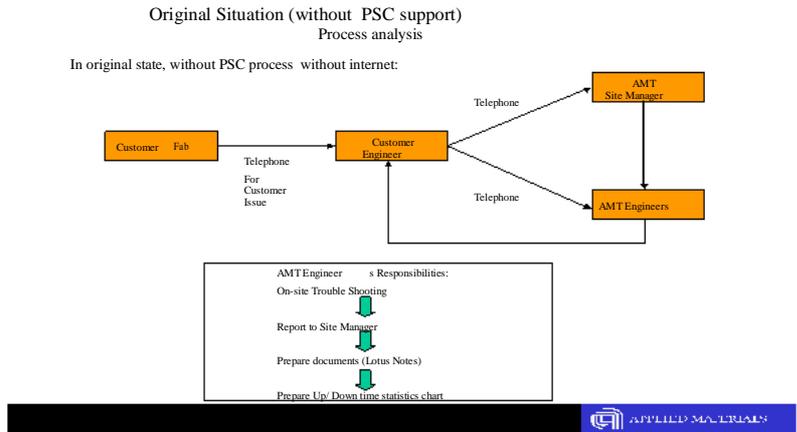


Figure 1: Original Situation (without P-S-C support)

### 1. Solutions

As indicated in Fig. 1, the original service situation is not real time, no service record, and no standard format to collect field trouble-shooting experience.

The customer decides when to make the phone call of any issue and there is no service record of the time involved trouble-shooting for any issue. In addition, after the issue is solved, the experience remains inside the engineer's head.

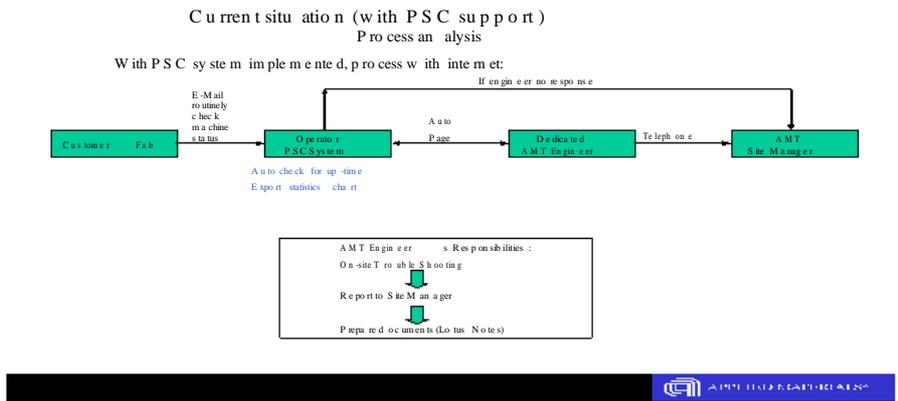


Figure 2: Current situation (with P-S-C support)

Table 1: Benefit Analysis of Original Service Situation v.s. Proactive Service Center (P-S-C)

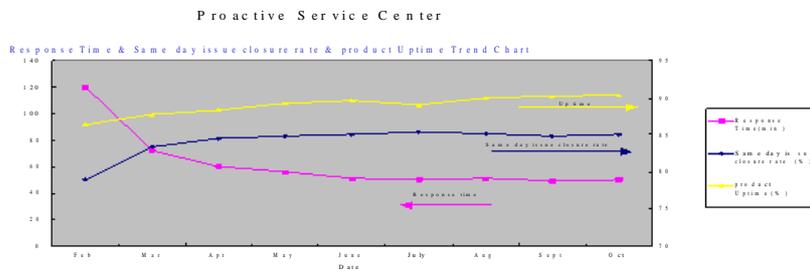
Category	Original Service Situation	Proactive Service Center	Benefit
Mechanism	Reactive	Proactive	The support mechanism is now proactive instead of reactive to wait for issue to happen. Research can be done for each issue before discussing with customers. This has shortened the issue cycle time.
Issue	Delayed	Real Time	Issue cycle time is shortened since there is no time delay in waiting for each issue to be reported.
Satisfaction Index (Same Day Issue Closure Rate)	N/A	Available	Same day issue closure rate is recorded in the P-S-C database and can be calculated regularly. This meaningful index can be monitored to enhance customer satisfaction.
Satisfaction Index (Issue Response Time)	N/A	Available	Issue response time is calculated automatically in the P-S-C database and this meaningful index can be monitored to enhance customer satisfaction.
System Uptime	Maintain	Maximize	Since the issue cycle time is shortened, the system uptime performance is maximized.
Troubleshooting Guide	N/A	Systematically Build-Up	Troubleshooting guide is built up systematically from engineers' service report which enhances engineering capability and improve system uptime.

As indicated in Fig. 2, the current service model is real-time with service record in the PSC system. In addition, the software is written to include auto checking and alarming functions for low uptime systems and it systematically collects field trouble-shooting actions done by engineers.

In short, when there is a variation in system normal condition, then the system automatically sends out the abnormal message to the customer server. The AMT server receives the message and page the system's dedicated engineer automatically. The engineer

responsible for the system response to the operator at the P-S-C, acknowledge receiving the pager and with on-site arriving time. After the issue is resolved, the engineer will fill out the service report with actions done.

The new service model, P-S-C, is real-time in issue feedback with service record and the engineer's trouble-shooting experience is systematically documented for future reference. The PSC solution is proven sustainable over time as indicated in the results trend chart. Fig. 3: Results Trend Chart.



## 2. Product Excellence

The benefit of P-S-C is summarized in Table 1. The P-S-C mechanism is proactive and shorten the issue cycle time. The issue is real time acknowledged to shorten cycle time. The customer satisfaction index previously not available such as same day issue closure rate and issue response time are now available to enhance customer satisfaction. In addition, the system uptime is now maximized since the issue cycle time is shortened. The P-S-C process is systematically collecting engineers' service report which serves as the base to build up the field trouble-shooting guide. The field trouble-shooting guide can be used to enhance engineering capability and improve system uptime.

In addition, the PSC has accumulated historical data on each system. Data analysis are done and included in the Monthly Report. The data analysis includes top 3 root causes for downtime and actions done which can be used to forecast future manpower arrangement and materials allocation. This means the

data analysis from PSC can be used proactively for future manpower or materials planning.

## 3. Model of Proactive Service Center

The model of P-S-C is shown in Fig.4 and management theory framework of P-S-C is documented in Fig. 5 and it includes the Infrastructure, Methods and Theories and Application of P-S-C. In addition to Internet, the infrastructure is based on Knowledge Management. P-S-C is a systematic way to document engineering field knowledge. During P-S-C implementation, it is crucial the customers fully understand the security and technology of P-S-C. The application of P-S-C can be shown in Fig. 4 to be Cycle Time Enhancement, One-to-One System Historical Record, Engineering Trouble-Shooting Build-Up, Proactive Service Provider and finally customer satisfaction leverage to create Win-Win-Win situation among AMT, customers and customers' customers.

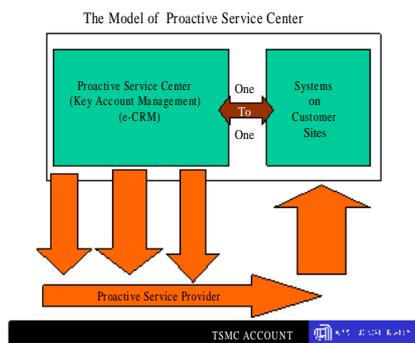


Fig. 4: The Application Model of Proactive Service Center

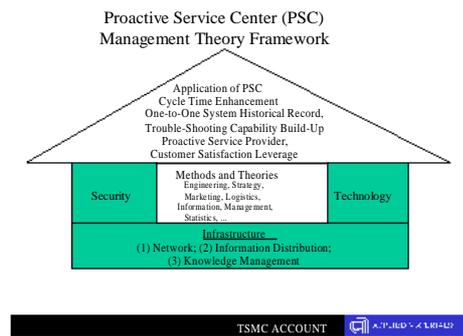
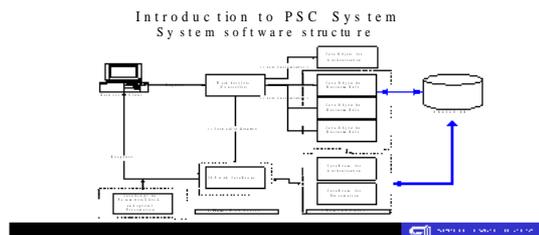


Fig.5: Management Theory Framework

## Reference

Software structure: We include the following software structure for IT reference.



# Quality Management for an E-Commerce Network Under Budget Constraint

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## Abstract

In general, several types of information data are transmitted through an E-Commerce network simultaneously. Each type of information data is set to one type of commodity. Under the budget constraint, this paper studies the probability that a given amount of multicommodity can be transmitted through an E-Commerce network, where each node and each arc has several possible capacities. We may take this probability as a performance index for this network. Based on the properties of minimal paths, a simple algorithm is proposed to generate all lower boundary points for  $(d^1, d^2, \dots, d^p; C)$  where  $d^i$  is the demand of commodity  $i$  and  $C$  is the budget. The probability can then be calculated in terms of such points.

## 1. Introduction

The capacity of each arc (the maximum flow passing the arc per unit time) in a binary-state flow network has two levels, 0 and a positive integer. For perfect nodes case, Aggarwal et al. [1] computed the system reliability, the probability that the maximum flow of the network is not less than the demand, in terms of minimal paths (MPs). A MP is an ordered sequence of arcs from the source  $s$  to the sink  $t$  that has no cycle. Lee et al. [10] and Rueger [15] extended the system reliability problem to the case that nodes and arcs have a positive-integer capacity and may fail. A stochastic-flow network is a multi-state network in which each arc has several states or capacities. The system reliability is the probability that the maximum flow of single-commodity through the network is not less than the demand  $d$ . Without the budget constraint, several authors [11,12,14,19,21] had presented algorithms to generate lower boundary points for  $d$  in order to evaluate the system reliability for perfect node case. Lin [13] and Yeh [22] extended the problem to the more general case that nodes have several capacities as arcs do.

However, in real world, many stochastic-flow networks allow multicommodity to be transmitted from  $s$  to  $t$  simultaneously. Assuming the flow network is deterministic (i.e., the capacity of each arc is a constant), many authors [3,4,8,17,18] studied the multicommodity minimum cost flow problem, which is to minimize the total cost of multicommodity. The purpose of this paper is to extend the system reliability problem to a

multicommodity case, named multicommodity reliability here, for a stochastic-flow network with node failure under budget constraint. Then a MP is an ordered sequence of arcs and nodes from  $s$  to  $t$  that has no cycle. The system reliability is the probability that the given demand  $(d^1, d^2, \dots, d^p)$  can be transmitted through the stochastic-flow network under budget  $C$ , where  $d^k$ ,  $k = 1, 2, \dots, p$ , is the required demand of commodity  $k$ . A simple algorithm is proposed to generate all lower boundary points for  $(d^1, d^2, \dots, d^p; C)$ , then the multicommodity reliability can be computed in terms of all lower boundary points for  $(d^1, d^2, \dots, d^p; C)$ .

## 2. Multicommodity Model Under Budget Constraint

$G = (A, N, M)$  is a stochastic-flow network with source  $s$  and sink  $t$  where  $A = \{a_i | 1 \leq i \leq n\}$  the set of arcs,  $N = \{a_i | n+1 \leq i \leq n+r\}$  the set of nodes and  $M = (M_1, M_2, \dots, M_{n+r})$  with  $M_i$  the maximal capacity of  $a_i$ . Let  $x_i$  denote the (current) capacity of  $a_i$  and it takes values from  $\{0, 1, 2, \dots, M_i\}$  with a given probability distribution.

### 2.1 Assumptions and Nomenclature

1. All commodities are transmitted from  $s$  to  $t$ .
2. The capacities of different arcs are statistically independent.

$\lceil x \rceil$  the smallest integer such that  $\lceil x \rceil \geq x$

$Y \geq X$   $(y_1, y_2, \dots, y_{n+r}) \leq (x_1, x_2, \dots, x_{n+r})$  if and only if  $y_i \geq x_i$  for  $i = 1, 2, \dots, n+r$

$Y > X$   $(y_1, y_2, \dots, y_{n+r}) > (x_1, x_2, \dots, x_{n+r})$  if and only if  $Y \geq X$  and  $y_i > x_i$  for at least one  $i$

### 2.2 Multicommodity Flow

Suppose  $P_1, P_2, \dots, P_m$  are MPs from  $s$  to  $t$ . The multicommodity flow model for  $G$  is described in terms of the capacity vector  $X = (x_1, x_2, \dots, x_{n+r})$  and the flow assignment  $(F^1, F^2, \dots, F^p)$ , where  $F^k = (f_1^k, f_2^k, \dots, f_m^k)$  with  $f_j^k$  denoting the flow (integer-value) of commodity  $k$  through  $P_j$ ,  $j = 1, 2, \dots, m$ ,  $k = 1, 2, \dots, p$ . Such an  $(F^1, F^2, \dots, F^p)$  which is feasible under  $X$  satisfies the following condition:

$$\sum_{k=1}^p (\varpi_i^k \cdot \sum_{a_i \in P_i} f_j^k) \leq x_i \text{ for } i = 1, 2, \dots, n+r, \quad (1)$$

where  $\varpi_i^k$  (real number) is the weight of commodity  $k$  on  $a_i$  i.e., the consumed amount of capacity on  $a_i$  per commodity  $k$ . For convenience, let  $\Phi_X$  denote the set of  $(F^1, F^2, \dots, F^p)$  feasible under  $X$ . Similarly,  $(F^1, F^2, \dots, F^p) \in \Phi_M$  if it satisfies

$$\sum_{k=1}^p (\varpi_i^k \cdot \sum_{a_i \in P_i} f_j^k) \leq M_i \text{ for } i = 1, 2, \dots, n+r. \quad (2)$$

Let  $c_i^k$  denote the transportation cost of each commodity  $k$  through  $a_i$ . Under  $X$ , the network  $G$  satisfies the given demand  $(d^1, d^2, \dots, d^p)$  under the budget  $C$  if there exists an  $(F^1, F^2, \dots, F^p) \in \Phi_X$  satisfying constraints (3) and (4);

$$\sum_{j=1}^m f_j^k = d^k, \quad k = 1, 2, \dots, p \quad (3)$$

$$\sum_{i=1}^{n+r} \sum_{k=1}^p c_i^k \cdot \sum_{a_i \in mp_j} f_j^k \leq C. \quad (4)$$

Let  $\Omega = \{X \mid \text{there exists an } (F^1, F^2, \dots, F^p) \in \Phi_X \text{ satisfying constraints (3) and (4)}\}$ . The multicommodity reliability  $R_{d^1, d^2, \dots, d^p; C}$  is thus

$$R_{d^1, d^2, \dots, d^p; C} = \Pr\{\Omega\} = \sum_{X \in \Omega} \Pr\{X\}$$

Each minimal one in  $\Omega$  is named a lower boundary point for  $(d^1, d^2, \dots, d^p; C)$  throughout this paper i.e.,  $X$  is a lower boundary point for  $(d^1, d^2, \dots, d^p; C)$  if and only if i)  $X \in \Omega$  and ii)  $Y \notin \Omega$  for any capacity vector  $Y$  such that  $Y < X$ . Hence,

$$R_{d^1, d^2, \dots, d^p; C} = \Pr\{Y \mid Y \geq X \text{ for a lower boundary point for } (d^1, d^2, \dots, d^p; C) \mid X\}.$$

### 2.3 Generate All Lower Boundary Points for $(d^1, d^2, \dots, d^p; C)$

Let  $\Phi = \{(F^1, F^2, \dots, F^p) \mid (F^1, F^2, \dots, F^p) \text{ satisfies constraints (2) - (4)}\}$ . For each  $(F^1, F^2, \dots, F^p) \in \Phi$ , generate the capacity vector  $Z_{F^1, F^2, \dots, F^p} = (z_1, z_2, \dots, z_{n+r})$

via

$$z_i = \sum_{k=1}^p (\varpi_i^k \cdot \sum_{a_i \in P_i} f_j^k) \text{ for } i = 1, 2, \dots, n+r. \quad (5)$$

For convenience, let  $\Psi = \{Z_{F^1, F^2, \dots, F^p} \mid (F^1, F^2, \dots, F^p) \in \Phi\}$ .

We will first see that  $\Psi$  contains all lower boundary points for  $(d^1, d^2, \dots, d^p; C)$  in the following lemma.

**Lemma 1.** Let  $X$  be a lower boundary point for  $(d^1, d^2, \dots, d^p; C)$ . Then  $X = Z_{F^1, F^2, \dots, F^p}$  for each  $(F^1, F^2, \dots, F^p) \in \Phi_X \cap \Phi$ .

**Proof:** For each  $(F^1, F^2, \dots, F^p) \in \Phi_X \cap \Phi$ , constraint (1) says that  $Z_{F^1, F^2, \dots, F^p} \leq X$ . Suppose that  $Z_{F^1, F^2, \dots, F^p} < X$ , then  $Z_{F^1, F^2, \dots, F^p} \notin \Omega$  as  $X$  is minimal in  $\Omega$ . This is a contradiction. Hence,  $X = Z_{F^1, F^2, \dots, F^p}$ .  $\square$

The following lemma further shows that  $\Psi_{\min} \equiv \{X \mid X \text{ is minimal in } \Psi\}$  is the set of lower boundary point for  $(d^1, d^2, \dots, d^p; C)$ .

**Lemma 2.**  $\{X \mid X \text{ is a lower boundary point for } (d^1, d^2, \dots, d^p; C)\} = \Psi_{\min}$ .

**Proof:** Firstly, suppose that  $X$  is a lower boundary point for  $(d^1, d^2, \dots, d^p; C)$  (note that  $X \in \Psi$  by lemma 1) but  $X \notin \Psi_{\min}$  i.e., there exist a  $Y \in \Psi$  such that  $Y < X$ . Then  $Y \in \Omega$ , which contradicts to that  $X$  is a lower boundary point for  $(d^1, d^2, \dots, d^p; C)$ . Hence,  $X \in \Psi_{\min}$ .

Conversely, suppose that  $X \in \Psi_{\min}$  (note that  $X \in \Omega$ ) but it is not a lower boundary point for  $(d^1, d^2, \dots, d^p; C)$ . Then there exists a lower boundary point for  $(d^1, d^2, \dots, d^p; C)$   $Y$  s.t.  $Y < X$ . By lemma 1,  $Y \in \Psi$  that contradicts to that  $X \in \Psi_{\min}$ . Hence,  $X$  is a lower boundary point for  $(d^1, d^2, \dots, d^p; C)$ .  $\square$

### 3. Algorithm

As those approaches of [11,13,14,19,21,22] we suppose all MPs have been pre-computed. Minimal paths can be efficiently derived from those algorithms discussed in [2,9,16]. The algorithm of Al-Ghanim [2] showed an approximate linear time response versus the number of network nodes. Kobayashi and Yamamoto [9] showed that to generate all minimal paths for a random network with 30 nodes and 100 arcs takes no more than 1300 seconds.

**Step 1.** Obtain all  $(F^1, F^2, \dots, F^p)$  with  $F^k = (f_1^k, f_2^k, \dots, f_m^k)$ ,  $k = 1, 2, \dots, p$ , of the following constraints:

$$\sum_{k=1}^p (\varpi_i^k \cdot \sum_{a_i \in P_i} f_j^k) \leq M_i \text{ for } i = 1, 2, \dots, n+r \quad (5)$$

$$\sum_{j=1}^m f_j^k = d^k, \quad k = 1, 2, \dots, p \quad (6)$$

$$\sum_{i=1}^{n+r} \sum_{k=1}^p c_i^k \cdot \sum_{a_i \in mp_j} f_j^k \leq C \quad (7)$$

**Step 2.** Transform each  $(F^1, F^2, \dots, F^p)$  into  $X = (x_1, x_2, \dots, x_{n+r})$  according to

$$x_i = \left\lfloor \sum_{k=1}^p (\omega_i^k \cdot \sum_{a_j \in P_j} f_j^k) \right\rfloor \text{ for } i = 1, 2, \dots, n + r \quad (8)$$

Step 3. Suppose  $\Psi = \{X_1, X_2, \dots, X_v\}$ .

- 3.1)  $I = \emptyset$  ( $I$  is the stack which stores the index of each non-minimal  $X$  after checking. Initially,  $I = \emptyset$ .)
- 3.2) For  $i = 1$  To  $v$  and  $\notin I$
- 3.3) For  $j = i + 1$  To  $v$  with  $\notin I$
- 3.4) If  $X_i \geq X_j$ ,  $I = I \cup \{i\}$  and go to step 3.7) Elseif  $X_j > X_i$ ,  $I = I \cup \{j\}$
- 3.5)  $j = j + 1$
- 3.6)  $X_i$  is a lower boundary point for  $(d^1, d^2, \dots, d^p; C)$
- 3.7)  $i = i + 1$
- 3.8) End.

#### 4. A numerical example

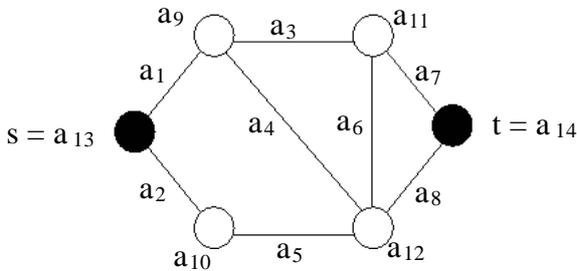


Figure 1. A benchmark [14,20]

We use the benchmark [14,20] in Figure 1 to illustrate the proposed approach. There are 7 MPs:  $P_1 = \{a_{13}, a_1, a_2, a_3, a_{11}, a_7, a_{14}\}$ ,  $P_2 = \{a_{13}, a_1, a_2, a_3, a_{11}, a_6, a_{12}, a_8, a_{14}\}$ ,  $P_3 = \{a_{13}, a_1, a_2, a_4, a_{12}, a_8, a_{14}\}$ ,  $P_4 = \{a_{13}, a_1, a_2, a_4, a_2, a_6, a_{11}, a_7, a_{14}\}$ ,  $P_5 = \{a_{13}, a_2, a_{10}, a_5, a_{12}, a_6, a_{11}, a_7, a_{14}\}$  and  $P_6 = \{a_{13}, a_2, a_{10}, a_5, a_{12}, a_4, a_2, a_3, a_{11}, a_7, a_{14}\}$ . The data of arcs and nodes for 2-commodity case are shown in Table 1. We assume the source and the sink both have infinite capacity and are perfect. If the demand  $(d_1, d_2)$  is set to be  $(3,3)$  and  $C = 810$  US dollars, then the multicommodity reliability  $R_{3,3;810}$  can be calculated by the following steps.

Step 1. Obtain all  $F^1 = (f_1^1, f_2^1, f_3^1, f_4^1, f_5^1, f_6^1, f_7^1)$ , and  $F^2 = (f_1^2, f_2^2, f_3^2, f_4^2, f_5^2, f_6^2, f_7^2)$  of the following integer-programming:

- (9)  $a_1: \begin{cases} f_1^1 + f_2^1 + f_3^1 + f_4^1 + 2f_5^1 + 2f_6^1 + 2f_7^1 \\ 2f_5^2 + 2f_6^2 \leq 5 \end{cases}$
- $a_2: f_5^1 + f_6^1 + f_7^1 + 2f_5^2 + 2f_6^2 + 2f_7^2 \leq 5$
- $a_3: f_1^1 + f_2^1 + f_7^1 + 2f_2^2 + 2f_5^2 + 2f_7^2 \leq 5$
- $a_4: f_3^1 + f_4^1 + f_7^1 + 2f_3^2 + 2f_4^2 + 2f_7^2 \leq 5$
- $a_5: f_5^1 + f_6^1 + f_7^1 + 2f_5^2 + 2f_6^2 + 2f_7^2 \leq 5$
- $a_6: f_2^1 + f_4^1 + f_6^1 + 2f_2^2 + 2f_4^2 + 2f_6^2 \leq 5$

- $a_7: \begin{cases} f_1^1 + f_4^1 + f_6^1 + f_7^1 + 2f_5^2 + 2f_6^2 + 2f_7^2 \\ 2f_5^2 + 2f_6^2 \leq 5 \end{cases}$
- $a_8: f_2^1 + f_3^1 + f_5^1 + 2f_2^2 + 2f_3^2 + 2f_5^2 \leq 5$
- $a_9: \begin{cases} f_1^1 + f_2^1 + f_3^1 + f_4^1 + f_7^1 + 2f_2^2 + 2f_3^2 + 2f_5^2 + 2f_6^2 + 2f_7^2 \\ 2f_5^2 + 2f_6^2 + 2f_7^2 \leq 9 \end{cases}$
- $a_{10}: f_5^1 + f_6^1 + f_7^1 + 2f_5^2 + 2f_6^2 + 2f_7^2 \leq 9$
- $a_{11}: \begin{cases} f_1^1 + f_2^1 + f_4^1 + f_6^1 + f_7^1 + 2f_2^2 + 2f_3^2 + 2f_5^2 + 2f_6^2 + 2f_7^2 \\ 2f_5^2 + 2f_6^2 + 2f_7^2 \leq 9 \end{cases}$
- $a_{12}: \begin{cases} f_2^1 + f_3^1 + \dots + f_7^1 + 2f_2^2 + 2f_3^2 + \dots + 2f_7^2 \\ \leq 9 \end{cases}$

$$(10) \begin{cases} f_1^1 + f_2^1 + f_3^1 + f_4^1 + f_5^1 + f_6^1 + f_7^1 = 3 \\ f_1^2 + f_2^2 + f_3^2 + f_4^2 + f_5^2 + f_6^2 + f_7^2 = 3 \end{cases}$$

$$(11) \begin{cases} 10(f_1^1 + f_2^1 + f_3^1 + f_4^1) + 20(f_1^2 + f_2^2 + f_3^2 + f_4^2) + \{20(f_5^1 + f_6^1 + f_7^1) + 30(f_5^2 + f_6^2 + f_7^2)\} + \{30(f_1^1 + f_2^1 + f_7^1) + 40(f_1^2 + f_2^2 + f_7^2)\} + \{20(f_3^1 + f_4^1 + f_7^1) + 40(f_3^2 + f_4^2 + f_7^2)\} + \{10(f_5^1 + f_6^1 + f_7^1) + 20(f_5^2 + f_6^2 + f_7^2)\} + \{20(f_2^1 + f_4^1 + f_6^1) + 30(f_2^2 + f_4^2 + f_6^2)\} + \{30(f_1^1 + f_4^1 + f_6^1 + f_7^1) + 40(f_1^2 + f_4^2 + f_6^2 + f_7^2)\} + \{20(f_2^1 + f_3^1 + f_5^1) + 40(f_2^2 + f_3^2 + f_5^2)\} + \{20(f_1^1 + f_2^1 + f_3^1 + f_4^1 + f_7^1) + 30(f_1^2 + f_2^2 + f_3^2 + f_4^2 + f_7^2)\} + \{20(f_5^1 + f_6^1 + f_7^1) + 30(f_5^2 + f_6^2 + f_7^2)\} + \{20(f_1^1 + f_2^1 + f_4^1 + f_6^1 + f_7^1) + 30(f_1^2 + f_2^2 + f_4^2 + f_6^2 + f_7^2)\} + \{20(f_2^1 + f_3^1 + \dots + f_7^1) + 30(f_2^2 + f_3^2 + \dots + f_7^2)\} \leq 810 \end{cases}$$

Seven  $(F^1, F^2)$  are obtained:  $(3, 0, 0, 0, 0, 0, 0)$ ,  $(0, 0, 1, 0, 0, 0, 0)$ ,  $(2, 0, 0, 0, 0, 0, 0)$ ,  $(0, 1, 0, 0, 0, 0, 0)$ ,  $(0, 0, 1, 0, 0, 0, 0)$ ,  $(1, 0, 0, 0, 2, 0, 0)$ ,  $(2, 0, 0, 0, 1, 0, 0)$ ,  $(0, 0, 1, 0, 2, 0, 0)$ ,  $(2, 0, 0, 0, 1, 0, 0)$ ,  $(0, 0, 0, 0, 3, 0, 0)$ ,  $(2, 0, 0, 0, 1, 0, 0)$  and  $(0, 0, 0, 0, 2, 1, 0, 2, 0, 0, 0, 1, 0, 0)$ . And the corresponding costs are 790, 790, 780, 780, 780, 770 and 810, respectively.

Step 2. Transform all  $(F^1, F^2)$  into  $X = (x_1, x_2, \dots, x_{12})$  according to

$$x_1 = \begin{cases} f_1^1 + f_2^1 + f_3^1 + f_4^1 + 2f_5^2 + 2f_6^2 + 2f_7^2 \\ 2f_5^2 + 2f_6^2 \end{cases}$$

$$\begin{aligned}
x_2 &= [f_5^1 + f_6^1 + f_7^1 + 2f_5^2 + 2f_6^2 + 2f_7^2] \\
x_3 &= [f_1^1 + f_2^1 + f_7^1 + 2f_2^2 + 2f_5^2 + 2f_7^2] \\
x_4 &= [f_3^1 + f_4^1 + f_7^1 + 2f_3^2 + 2f_4^2 + 2f_7^2] \\
x_5 &= [f_5^1 + f_6^1 + f_7^1 + 2f_5^2 + 2f_6^2 + 2f_7^2] \\
x_6 &= [f_2^1 + f_4^1 + f_6^1 + 2f_2^2 + 2f_4^2 + 2f_6^2] \quad (12) \\
x_7 &= [f_1^1 + f_4^1 + f_6^1 + f_7^1 + 2f_2^2 + 2f_4^2 + \\
&\quad 2f_6^2 + 2f_7^2] \\
x_8 &= [f_2^1 + f_3^1 + f_5^1 + 2f_2^2 + 2f_3^2 + 2f_5^2] \\
x_9 &= [f_1^1 + f_2^1 + f_3^1 + f_4^1 + f_7^1 + 2f_2^2 + \\
&\quad 2f_3^2 + 2f_4^2 + 2f_7^2] \\
x_{10} &= [f_5^1 + f_6^1 + f_7^1 + 2f_5^2 + 2f_6^2 + 2f_7^2] \\
x_{11} &= [f_1^1 + f_2^1 + f_4^1 + f_6^1 + f_7^1 + 2f_2^2 + \\
&\quad 2f_4^2 + 2f_6^2 + 2f_7^2] \\
x_{12} &= [f_2^1 + f_3^1 + \dots + f_7^1 + 2f_2^2 + 2f_3^2 + \\
&\quad \dots + 2f_7^2]
\end{aligned}$$

We obtain  $X_1 = (5, 4, 5, 0, 4, 0, 5, 4, 5, 4, 5, 4)$ ,  $X_2 = (5, 4, 4, 1, 4, 0, 4, 5, 5, 4, 4, 5)$ ,  $X_3 = (4, 5, 4, 0, 5, 0, 4, 5, 4, 5, 4, 5)$ ,  $X_4 = (5, 4, 5, 0, 4, 0, 5, 4, 5, 4, 5, 4)$ ,  $X_5 = (5, 4, 4, 1, 4, 0, 4, 5, 5, 4, 4, 5)$ ,  $X_6 = (4, 5, 4, 0, 5, 0, 4, 5, 4, 5, 4, 5)$  and  $X_7 = (4, 5, 4, 0, 5, 1, 5, 4, 4, 5, 5, 5)$ .

Step 3. Check each  $X_i$  whether it is a lower boundary point for (3,3;810) or not.

- 3.1)  $I = \emptyset$
- 3.2)  $i = 1$
- 3.3)  $j = 2$
- 3.4)  $X_1 \not\geq X_2$  and  $X_2 \not\geq X_1$ .  $I = \{\emptyset\}$ .
- 3.3)  $j = 3$
- 3.4)  $X_1 \not\geq X_3$  and  $X_3 \not\geq X_1$ .  $I = \{\emptyset\}$ .
- 3.5)  $j = 4$
- 3.4)  $X_1 \geq X_4$ .  $I = \{1\}$ .
- 3.2)  $i = 2$

M

After further checking,  $X_4$ ,  $X_5$ ,  $X_6$  and  $X_7$  are all lower boundary points for (3,3;810). Let  $B_1 = \{X|X \geq X_4\}$ ,  $B_2 = \{X|X \geq X_5\}$ ,  $B_3 = \{X|X \geq X_6\}$  and  $B_4 = \{X|X \geq X_7\}$ . Hence, the multicommodity reliability  $R_{3,3;810} = \Pr\{B_1 \cup B_2 \cup B_3 \cup B_4\} = 0.61623376$  can be computed by the inclusion-exclusion method.

## 5. Conclusions

This article extends the system reliability problem to the multicommodity reliability for a stochastic-flow network with node failure under budget constraint. The multicommodity reliability is the probability that the demand  $(d^1, d^2, \dots, d^p)$  can be transmitted through the stochastic-flow network under budget  $C$ . Based on the properties of minimal paths, we propose a simple algorithm to generate all lower boundary point for  $(d^1, d^2, \dots, d^p; C)$ . Then the multicommodity reliability can be calculated in terms of lower boundary points for

$(d^1, d^2, \dots, d^p; C)$  by applying the inclusion-exclusion method. In our model the transportation cost  $c_i^k$  is not assumed to be linear in  $\omega_i^k$ . The main reason is that the transportation cost is not only dependent on the dimension of commodity but also on other attributes of commodity. For example, poison, vulnerable, fragile, etc. For the case that the transportation cost is only charged in terms of consumed capacity,  $c_i^k$  is linear in  $\omega_i^k$ . However, this condition is a special case of the proposed model.

## References

- [1] Aggarwal, K. K., Chopra, Y. C. and Bajwa, J. S., "Capacity consideration in reliability analysis of communication systems," IEEE Trans. Reliability, 1982, 31, 177-180.
- [2] Al-Ghanim, A. M., "A heuristic technique for generating minimal paths and cutsets of a general network," Computers and Industrial Engineering, 1999, 36, 45-55.
- [3] Cremeans, J. E., Smith, R. A. and Tyndall, G. R., "Optimal multicommodity network flows with resource allocation," Naval Research Logistics Quarterly, 1970, 17, 269-279.
- [4] Evans, J. R., "A combinatorial equivalence between a class of multicommodity flow problems and the capacitated transportation problem," Mathematical Programming, 1976, 10, 401-404.
- [5] Ford, L. R. and Fulkerson, D. R., Flows in networks, Princeton University Press, Princeton, New Jersey, 1962.
- [6] Griffith, W. S., "Multistate reliability models," Journal of Applied Probability, 1980, 17, 735-744.
- [7] Hudson, J. C. and Kapur, K. C., "Reliability bounds for multistate systems with multistate components," Operations Research, 1985, 33, 153-160.
- [8] Kennington, J. L., "Solving multicommodity transportation problems using a primal partitioning simplex technique," Naval Research Logistics Quarterly, 1977, 24, 309-325.
- [9] Kobayashi, K. and Yamamoto, H., "A new algorithm in enumerating all minimal paths in a sparse network," Reliability Engineering and System Safety, 1999, 65, 11-15.
- [10] Lee, D. W. and Yum, B. J., "Determination of minimal upper paths for reliability analysis of planar flow networks," Reliability Engineering & System Safety, 1993, 39, 1-10.
- [11] Lin, J. S., Jane, C. C. and Yuan, J., "On reliability evaluation of a capacitated-flow network in terms of minimal pathsets," Networks, 1995, 25, 131-138.
- [12] Lin, Y. K., "On Reliability Evaluation of a Stochastic-Flow Network in Terms of Minimal Cuts," Journal of Chinese Institute of Industrial Engineers, 2001, 18, 49-54.
- [13] Lin, Y. K., "A Simple Algorithm for Reliability Evaluation of a Stochastic-Flow Network with Node Failure," Computers and Operations Research, 2001, 28(13), 1277-1285.
- [14] Lin, Y. K. and Yuan, J., "A new algorithm to generate d-minimal paths in a multistate flow network with noninteger arc capacities," Int. J. Reliability, Quality, and Safety Engineering, 1998, 5, 269-285.
- [15] Rueger, W. J., "Reliability analysis of networks with capacity-constraints and failures at branches and nodes," IEEE Trans. Reliability, 1986, 35, 523-528.

- [16] Shen, Y., "A new simple algorithm for enumerating all minimal paths and cuts of a graph," *Microelectronics and Reliability*, 1995, 35, 973-976.
- [17] Tomlin, J. A., "Minimum-cost multicommodity network flows," *Operations Research*, 1966, 14, 45-51.
- [18] Weigel, H. S. and Cremeans, J. E., "The multicommodity network flow model revised to include vehicle per time period and node constraints," *Naval Research Logistics Quarterly*, 1972, 19, 77-89.
- [19] Xue, J., "On multistate system analysis," *IEEE Trans. Reliability*, 1985, 34, 329-337.
- [20] Soh, S. and Rai, S., "CAREL: Computer aided reliability evaluation for distributed computing networks," *IEEE Trans. Parallel & Distributed Systems* 1991, 2 199-213.
- [21] Yeh, W. C., "A revised layered-network algorithm to search for all d-minpaths of a limited-flow acyclic network," *IEEE Transactions on Reliability*, 1998, 47, 436-442.
- [22] Yeh, W. C., "A simple algorithm to search for all d-MPs with unreliable nodes," *Reliability Engineering & System Safety*, 2001, 73, 49-54.

Table 1. The data of arcs and nodes for 2-commodity example

Arc	Capacity	Probability	$\omega_i^1$	$\omega_i^2$	$c_i^1$ (US dollar)	$c_i^2$ (US dollar)
a <sub>1</sub>	0*	.01	1	2	10	20
	1	.01				
	2	.01				
	3	.02				
	4	.02				
a <sub>2</sub>	5	.93	1	2	20	30
	0	.01				
	1	.01				
	2	.02				
	3	.03				
a <sub>3</sub>	4	.03	1	2	30	40
	5	.90				
	0	.01				
	1	.01				
	2	.01				
a <sub>4</sub>	3	.02	1	2	20	40
	4	.02				
	5	.93				
	0	.01				
	1	.01				
a <sub>5</sub>	2	.02	1	2	10	20
	3	.03				
	4	.03				
	5	.90				
	0	.01				
a <sub>6</sub>	1	.01	1	2	20	30
	2	.02				
	3	.03				
	4	.03				
	5	.90				
a <sub>7</sub>	0	.01	1	2	30	40
	1	.01				
	2	.01				
	3	.02				
	4	.02				
a <sub>8</sub>	5	.93	1	2	20	40
	0	.01				
	1	.01				
	2	.02				
	3	.03				
a <sub>9</sub> ~ a <sub>12</sub>	4	.03	1	2	20	30
	5	.90				
	0	.01				
	1	.01				
	3	.01				
	5	.01				
	7	.02				
	9	.94				

\*Pr{the capacity of a is 0} = 0.01.

# Customers' Acceptance of a Web Site for Product Information Search

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## Abstract

A theoretical model of consumers' acceptance of a website to search for product information is constructed and empirically assessed in this study. The results suggest that, besides perceived usefulness and perceived ease of use, the concepts of perceived costs and perceived risks should be incorporated into the technology acceptance model to account for information search behavior on the new media. Moreover, the causal relationship between use intention and its antecedents is significantly different for search goods and experience goods. To support the task of product information search on a website, product categorization and consumers' evaluation of product quality information should be taken into consideration for website design. That is, the WWW technological applications employed to support product information search for search goods should be different from those used for experience goods.

## 1. Introduction

The Internet has become a popular communication tool between organizations and consumers since its commercial applications in mid 1990's. Among various marketing functions that are possibly supported by the Internet, informativeness is reported as the most important function of the net (Palmer and Griffith, 1998; Chen & Wells, 1999; Keeney, 1999). Supporting product information search is still one the most prominent purposes for many commercial web sites.

However, many of the Web sites are not effectively managed for supporting customer's information search

(Dutta, Kwan & Segev, 1998). In particular, many commercial web sites suffer from low acceptance from consumers (Lin & Lu, 2000). The following crucial questions are yet to be answered: What factors lead consumers to use a commercial web site to search for product information? How information technology on the Internet can support consumers to search information more effectively? Should websites offer the same or different technological features to support different kinds of products? The purpose of this paper is, hence, to construct a theoretical model to account for web site acceptance as product information tool in order to explore the answers to the above questions.

As proposed by Palmer and Griffith (1998), an effective commercial web site must address two issues: technical characteristics (i.e. audio, video, hyperlinks, and etc.) and

marketing functions (i.e. information, promotion, online sales and services). In the context of product information search, the corresponding issues are product information content and the technology used to support information search. These two components are complementary and essential for using Web sites. A glitzy web site without relevant information will not satisfy consumers' needs for reducing product quality uncertainty. Similarly, a web site with ample content needs advanced information search technology to facilitate consumers to process the information. Therefore, this study assesses consumers' evaluations of a web site on these two dimensions. The theoretical model proposed in this paper will hence incorporate theories concerning both issues.

## 2. Theoretical Bases and Research Model

In the research model investigated by this paper, customers' acceptance of a web site will be described in terms of (a) consumers' perceptions of the information search technology utilized on the web site and (b) consumers' evaluation of the product information provided on the web site. Given that web sites are applications of the new technology of the Internet, the technology acceptance model (Davis, 1998; Davis, 1993; Davis, Bagozzi & Warshaw, 1989) is appropriate to serve as the theoretical basis to account for web site acceptance. As for consumers' evaluation of product information, the well-acknowledge cost-benefit framework will be employed in the research model of this study.

### 2.1. Technology Acceptance Model

In the literature of MIS, technology acceptance model (abbreviated as TAM hereafter) proposed by Davis (1998; Davis, 1993; Davis, Bagozzi & Warshaw, 1989) has been widely used to account for user acceptance of new technology. In this theory, acceptance of new information technology (IT) is measured by use intention and use behavior of IT. According to TAM, perceived usefulness (abbreviated as PU) and perceived ease of use (abbreviated as PEOU) are the central beliefs leading to use intention towards IT. Some researches have recently extended this theory to the use of the Internet and found results congruent with previous studies (Agarwal & Prasad, 1997; Lin & Lu, 2000; Teo, Lim and Lai, 1999). Given that product information search on web sites is a common usage of the Internet, user's PU and PEOU of the web site should also account for intention of product information search on the site, as stated in hypotheses 1a and 1b.

Moreover, PU is also positively influenced by PEOU, as stated in the hypothesis 1c.

Hypothesis 1a: Use intention of a web site to search for product information is positively influenced by perceived usefulness of the web technology.

Hypothesis 1b: Use intention of a web site to search for product information is positively influenced by perceived ease of use of the web technology.

Hypothesis 1c: Perceived Usefulness is positively influenced by perceived ease of use in the context of WWW.

In addition to assessment of web technology, consumers' assessment of the product information provided on the web site is also critical for reuse and acceptance of it. The cost-benefit framework is discussed to explore the product information search behavior on WWW.

## 2.2. Cost-Benefit Framework and Product Quality Information

Marketing researches of product information search suggest that perceived benefits and perceived costs affect external product information search conducted by consumers (Beatty & Smith, 1987; Srinivasan & Ratchford, 1991; Newman, 1977). In the context of product information search, the perceived search costs refer to mental efforts, time and financial costs (Claxton, Fry & Portis, 1974; Bettman, 1979) and the perceived benefits refer to reduction of perceived risks (Taylor, 1974; Dowling & Staelin, 1994; Kaplan & Jacoby, 1974). The concept of perceived risks is defined as the uncertainty associated with purchasing a product. Perceived risks, first proposed by Bauer (1960), are used to explain for various stages of consumers' behavior, especially pre-purchase product information search (Mithell, 1992). Consumers are uncertain about the consequences of purchasing a product such that they engage in active information search from various information sources in order to reduce the uncertainty, namely perceived risks.

Nevertheless, the benefits of perceived risks reduction calls for costs of information search, which includes mental efforts, time and money as mentioned in the previous text. Stigler (1961) argued that consumers would seek for product information until the cost of doing so exceeds the benefit of further information. That is, a consumer's search for information is guided by a trade-off between the perceived costs of additional search and the expected benefits of that search.

However, perceived risks and perceived costs are different for different kinds of products and hence the trade-off relationship between perceived risks and perceived search costs might depend upon the category of the product. Products can be classified as search goods and experience goods. In the case of search goods, perceived risks are low and perceived costs are high as opposed to experience goods, for which perceived risk are high and perceived costs are low.

According to Nelson, products can be categorized by the time when product quality information is acquired. When the attribute claims can be verified through pre-purchase search activities, those attributes are called search attributes. And when the most important attribute of the product is search attribute, the product is called search product. On the other hand, when the attribute claim can only be verified after the product has been purchased and consumed, the attribute is called experience attribute. And experience products are those products whose most important attribute is experience attribute. The distinction of search vs. experience products is statistically reliable because people can reliably categorize products into search and experience (Ford, Smith & Sway, 1988).

When consumers search external information about experience qualities, they try to decrease perceived risks through information sources with low search costs. People are less willing to search for experience qualities than for search qualities (Maute & Forrester, 1991; Newman, 1977; Beatty and Smith, 1987; Jacoby, 1984; Ratchford & Gupta, 1987). perceived risk is positively related to use of informal information sources, such as word-and-mouth, opinion leaders, which usually requires lower search costs (Seth & Parvatiyar, 1995; Dowling & Staelin, 1994). In another word, in the case of information search for experience goods, perceived risks are high and perceived costs are low. It follows that to reduce perceived risks should be the major concern for consumers when searching product information for experience goods. On the other hand, in the case of search goods, people are more willing to search and more factual information is provided through advertising. This phenomenon implies that search costs are high for consumers who are engaged in searching information for search goods. Moreover, search qualities can be verified before purchasing the product and people are less skeptical of search qualities claims such that perceived risks for search goods should be low, at least lower than experience goods.

Based upon the above argumentation, it is proposed in this study that the importance of perceived risks and perceived costs are different kinds of products. That is, categorization of product plays a role as moderator for the causal relationship between perceived risks, perceived costs and use intention of WWW as an information search tool. This proposed moderator role of search and experience goods is in alignment with the findings of Maute & Forrester (1991), which have suggested that search and experience goods served as moderators of the relationship between search determinants and external search effort. Therefore, it is proposed that for search goods, reduction of perceived costs (abbreviated as RPSC hereafter) should thus positively influence use intention, as stated in hypothesis 2a. On the other hand, for experience goods, reduction of perceived risks (abbreviated as RPR hereafter) should thus have positive effect on use intention, as stated in hypothesis 2b.

Hypothesis 2a: For search goods, use intention of a web site to search for product information is positively

influenced by perceived search costs reduced through using the web site.

Hypothesis 2b: For experience goods, use intention of a web site to search for product information is positively influenced by perceived risk reduced through using the web site.

Given that to reduce perceived risks is an important reason to use WWW to search product information for experience goods, RPR should have positive effect on perceived usefulness of the used website in the context of experience goods. Similarly, RPSC should have positive effect on perceived usefulness of the website for searching product quality of search goods.

Hypothesis 2c: For search goods, RPSC positively influence perceived usefulness of the website.

Hypothesis 2d: For experience goods, RPR positively influence perceived usefulness of the website.

Some empirical researches have reported that TAM could be extended by adding the construct of task-technology fit to serve as the antecedent of IT perceptions (Dishaw & Strong, 1999). In the following text, the task-technology fit theory will be discussed and incorporated into the theoretical model of this study.

### 2.3. Task-Technology Fit theory

The concept of task-technology fit is defined as ideal profiles of task/technology alignment between characteristics of task and technology (Zigurs & Buckland, 1998; Venkatraman, 1989). In another word, the construct of task-technology fit refers to the degree of match between the two variables: task and technology. Various empirical results suggested that effect of task-technology fit could be mediated through user's beliefs and attitudes onto use intention and behavior (Goodhue & Thompson, 1995; Dishaw & Strong, 1999). The Internet as a new technology possesses various characteristics that can help people to perform the task of information search effectively and efficiently. The empirical results of Dishaw & Strong (1999), task-technology fit should be the direct antecedent of perceived usefulness and perceived ease of use. Therefore, it is proposed that task-technology fit should be the direct antecedent of perceived usefulness and perceived ease of use for using website to search product information of both search goods and experience goods, as stated in hypotheses 3a, 3b, 3d and 3e. Moreover, match between searching task and supporting technology should also have influences on reduction of perceived risks for experience goods and on reduction of perceived costs for search goods, as stated in hypotheses 3c and 3f.

Hypothesis 3a: For search goods, task-technology fit influences PU of the web site for product information search.

Hypothesis 3b: For search goods, task-technology fit influences PEOU of the web site for product information search.

Hypothesis 3c: For search goods, task-technology fit influences RPSC of the web site for product information

search.

Hypothesis 3d: For experience goods, task-technology fit influences PU of the web site for product information search.

Hypothesis 3e: For experience goods, task-technology fit influences PEOU of the web site for product information search.

Hypothesis 3f: For experience goods, task-technology fit influences RPR of the web site for product information search.

In the following text, we will explore how WWW technology can be used to support these different tasks for search goods and experience goods in order to achieve desirable level of task technology fit.

### 2.4. Technological Characteristics of WWW

The task of product information search could vary upon different kinds of products. Marketing researches suggest that verifiability of product quality lead people to focus on different aspects of information. When the product quality claims are easy to verify before purchase, consumers tend to search for so-called hard information which are the well-defined standard attributes of the product. That is, product quality information can be acquired through vast information search for search attributes, such as color of clothes, smell of perfume. On the other hand, people tend to look for soft information when search product quality information for experience goods. Soft information refers to the attributes of the product provided through personal opinion and impressions, such as good taste of foods, durability of computer. Given that product quality information for experience goods can not be acquired before use of the product, people resort to the opinions of those who have used it. Based upon the concept of task-technology fit, the website needs to provide the technology characteristics that help people to search for hard information in the situation of search goods, and soft information in the situation of experience goods.

WWW possesses many powerful technological functions that can support information search. Many researches have addressed on the technological characteristics of the Internet. For instance, Newhagen and Rafaeli (1996) asserted that

the characteristics idiosyncratic to the Internet media are multimedia, hypertext, interactivity and personalization. Kenney (1999) also proposed that the characteristics of the Internet that can satisfy customers are large amount of information, time saving, privacy, personalization and interactivity. Hoffman and Novak (1996) emphasized that interactivity is the feature that distinguish old media and the new media of Internet. Moreover, some large-scale surveys have been done to describe what technological functions attract people to use the Internet. Large information quantity, personalization and privacy are reported as the most important features to account for use of this new media (Ernst & Young, 1999; GVU, Forrester research).

Among the prominent features of the Internet are its temporal and spatial characteristics, which enable information searchers to overcome the limitations of time and space. For instance, people can search for timely information on the Internet 24 hours a day, connecting to the web sites all over the world through the function of hyperlink, even without walking out of his/her own house. At the same, the information searcher can keep his/her privacy about the action of search by keeping anonymous. The three characteristics, temporal characteristics, spatial characteristics and privacy are effective for information search.

In addition, some technological characteristics of the Internet can help providing hard information, such as information capacity, multi-media. On the other hand, search of soft information can be supported by the functions of personalization and interactivity. In conclusion, characteristics such as temporal, spatial, privacy, multimedia and information quantity are crucial to support task-technology fit in the context of search goods, as stated in hypotheses 4a-e. For experience goods, characteristics such as temporal, spatial, privacy, personalization and interactivity, as stated in hypotheses 4f-j.

Hypothesis 4 a-e: For search goods, task technology fit is influenced by the following technological supports: information quantity, multimedia, privacy, temporal characteristics, and spatial characteristics.

Hypothesis 4 f-j: For experience goods, task technology fit is influenced by the following technological supports: personalization, interactivity, privacy, temporal characteristics, and spatial characteristics.

### 3. Research Methods

#### 3.1. Operationalization of theoretical constructs

The measurement indexes of all the theoretical constructs in this research are adapted from relevant studies, to fit the situation of product information search on web sites. Please see Table 1 for related sources of constructs.

Table 1: Literature sources of the theoretical constructs

Construct	Measurement sources
Perceived Ease of Use (PEOU)	Davis (1989)
Perceived Usefulness (PU)	Davis (1989)
Use Intention	Chau (1996)
Reduction in Perceived Search Costs (RPSC)	Claxton, Fry & Portis, 1974; Bettman, 1979
Reduction in Perceived Risks (RPR)	Kaplan & Jacoby (1974)

Product quality information	Nelson (1986)
Task-Technology Fit	Goodhue & Thompson (1995)
Information quantity	Keeney (1999); Peterson, Balasubramanian & Bronnegger (1997)
Multimedia	Keeney (1999); Hoffman & Novak (1996); Daft & Lengel (1984)
Temporal characteristics	Richmond (1996); Schillewaert, Langerak & Kuhamel (1998)
Privacy	Keeney (1999); Richmond (1996)
Spatial characteristics	Schillewaert, Langerak & Kuhamel (1998); Keeney (1999)
Personalization	Daft & Lengel (1984)
Interactivity	Peterson, Balasubramanian & Bronnegger (1997)

#### 3.2. Sample

The respondents of the survey questionnaire are students randomly recruited from five university campuses in Taiwan, during January and March in 2000. In total, 272 questionnaires were distributed, and 264 of them were returned, with the response rate of 97.6%. Among the 264 returned questionnaires, 19 of them were invalid. So, the sample size was 245. Given that product quality information is hypothesized to be a moderator in our research model, the sample was split into two sub-samples: the search goods sub-sample and the experience goods sub-sample, according to how the respondent judged the assigned product. Respondents were randomly assigned to one of the six products (described in the next section of research material) chosen for this survey and were asked to judge the given product on a rating scale, from 1 to 7, with 1 referring to search goods and 7 to experience goods. The responses higher than average are categorized as experience goods and lower than average are categorized as search goods. Consequently, among the 245 valid responses, 125 were categorized into the search goods sub-sample, and 120 were categorized into the experience goods sub-sample. In order to see if other factors than product quality categorization distinguish the two sub-sample, the demographic data were analyzed. The results showed that these two sub-samples do not differ from each other in terms of the distributions of gender and age (Gender:  $\chi^2_{1} = .64, p < .20$ ; Age:  $\chi^2_{5} = 4.40, p < .42$ ). The result of this analysis suggests that these two sub-samples are demographically similar to each other.

### 3.3. Research Material

Six products were chosen to serve as the test products in this study, as demonstrated in Table 2. There were three criteria for choosing the products. First, the products have to be familiar to our respondents because people might not know what attributes are important for unfamiliar products. Secondly, the price of the products must be among the affordable range for our student respondents. Thirdly, the prices of products were controlled as close as possible because the price might affect respondents' perception of search costs and risk cost.

For each of the six products, two web sites were used for the survey. One web site is presumed to fit for supporting search goods and the other web site is presumed to fit for supporting experience good. In total, there were twelve websites chosen for this survey, and all respondents were randomly assigned to one of the website. The survey questionnaire involved two stages: pre-search section and post search section. The pre-search section includes three components: demographic information of the respondent, categorization of the assigned product and perceived search cost and risk cost of the product. The measured perceived search costs and perceived risk costs in the pre-search section will be compared against the perceived search costs and perceived risk costs of the same product measured in the post-search section, which measured the perceptions associated with website information search.

The post-search section involved measurements of the theoretical constructs in this study: product categorization, perceived usefulness, perceived ease of use, perceived risks, perceived search costs, intention to use, task technology fit and characteristics of the Internet. The construct of RPSC is measured by perceived search costs of post-search section, deducting the measurement of perceived search costs of pre-search section. The construct of RPR is measured by the same way.

### 3.4. Survey procedures

The task of respondents was to gather product quality information on the website to facilitate buying decision and also to evaluate the assigned web site for future visit. Every respondent was randomly assigned one of the above 12 web sites as the virtual space to search for shopping information. Before search, every respondent was asked to fill out the pre-search section of the questionnaire. Then, respondents searched for the product information on the assigned web site in their pace. When the search was complete, respondents were asked to evaluate the website by filling out the post-search section.

### 3.5. Data analysis

The data of both sub-samples were analyzed in the same way through Lisrel 8, developed by Joreskog & Sorbom (1993). Lisrel 8, as confirmatory factor analysis,

involves two stages: measurement model and structural model. The analysis of measurement model was first evaluated against three criteria: item reliability, composite reliability and discriminant validity. As for the structural model, the various indexes of goodness of fit were analyzed to test if the hypothetical models discussed in the previous text were suitable to describe the collected data. Moreover, direct, indirect and total effects of the independent variables on the dependent variables were analyzed.

## 4. Results Discussion and Conclusions

### 4.1. Measurement model analysis of Search Goods and Experience Goods

The assessments of both measurement models of search goods and experience goods indicate that reliability, convergent validity and discriminant validity of the hypothetical constructs are considerably adequate.

Three measures were used to examine reliability and validity of the measurement indexes: item reliability, construct reliability and average variance extracted. Those measurement indexes that did not fulfill the criteria (Bagozzi & Yi, 1988) were all deleted from further analysis. For the construct of perceived difference in search cost (abbreviated as RPSC), only one index was left, which is difference in search time. Therefore, in the following analysis, the construct of RPSC was replaced by reduction of perceived search time.

Composite reliability and the average variance extracted are calculated to assess convergent validity. The minimum value of composite construct is .60, and that of average variance extracted, .50, for evidence of convergent validity. The composite reliabilities of all the theoretical constructs are all above .60, and average variance extracted, all above .50, showing that the convergent validity of those constructs in the measurement models of both search goods and experience goods were adequate. Nevertheless, for the constructs of perceived difference in search cost, temporal characteristics, only one measurement index was left and hence the composite reliability could not be calculated.

Most of the inter-correlations of the items between constructs are smaller than the correspondent average variance extracted (89% for search goods, and 80% for experience goods), indicating high discriminant validity for both measurement model. Beside adequate convergent validity, the discriminant validity for the measurement model of experience goods is considerably fair.

### 4.2. Structural Model analysis of Search Goods and Experience Goods

The difference between the structural models of search goods and experience goods was statistically significant by using multiple sample analysis ( $\chi^2_{103} = 221.48, p < .001$ ). That is, the causal relationships of the variables discussed

are different among search goods and experience goods. Therefore, the data of search goods and experience goods were hence analyzed separately.

The goodness-of-fit of these two structural models are measured by seven index,  $\chi^2/df$ , GFI, AGFI, RMSR, NFI, NNFI and CFI to assess if the collected data could be described by our models. For both search goods and experience goods, some goodness-of-fit measurements of the original structural models do not fulfill the minimum requirements. Therefore, the structural models are modified according to the suggestions provided by LISREL such that all the values of the seven indexes fulfill the minimum requirements. The results of the data collected in this research are examined to see if the hypotheses are supported.

### Effects on Use Intention

The results show that the construct of PU significantly affects use intention ( $\beta=.60$ ,  $p<.01$  for search goods,  $\beta=.57$ ,  $p<.01$  for experience goods). However, there is no direct effect of PEOU on use intention. Nevertheless, PEOU affects use intention indirectly through perceived usefulness. PEOU directly affects PU ( $\beta=.32$ ,  $p<.01$  for search goods and  $\beta=.17$ ,  $p<.01$  for experience goods), which further mediates the effects of PEOU on use intention ( $\beta=.19$ ,  $p<.01$  for search goods and  $.10$  n.s. for experience goods). Hypotheses 1a and 1c are supported by hypothesis 1b is partially supported by our data. In another word, use intention of WWW is directly affected by PU and indirectly affected by PEOU.

Moreover, use intention is also predicted to be affected by RPSC in the context of search goods, and to be affected by RPR in the context of experience goods, as stated by hypotheses 2a and 2b. In the context of search goods, perceived difference in search time affects use intention ( $\beta=.14$ ,  $p<.01$ ) although the effect is indirectly mediated through PU. As for experience goods, perceived difference in risk costs directly affects use intention ( $\beta=.13$ ,  $p<.05$ ). Hypotheses 2a is partially and 2b is fully supported by our data. In conclusion, use intention is affected by different factors for search goods and experience goods.

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### Effects on the Perceptions

According to the hypotheses 2c, 2d, and 3a-f, the precedents of the perceptions of WWW are also different for search goods and experience goods. The construct of PU is affected by PEOU ( $\beta=.32$ ,  $p<.01$ ), RPSC ( $\beta=.24$ ,  $p<.01$ ) and TTF ( $\beta=.67$ ,  $p<.01$ ) for search goods. On the other hand, the construct of PU is affected by PEOU ( $\beta=.17$ ,  $p<.01$ ) and TTF ( $\beta=.58$ ,  $p<.01$ ) for experience goods. As for PEOU, it is not affected by TTF for search goods, but affected by TTF for experience goods ( $\beta=.54$ ,  $p<.01$ ). Hypotheses 2d, 3a, 3e and 3d are supported by the results, but hypothesis 2c and 3b are not supported. Moreover, the perceptions of both risk costs and search costs are not affected by TTF for both kinds of products. Hypotheses 3c and 3f are not supported by the results.

### Effects on Task-Technology Fit

Task-technology fit can be achieved by technological characteristics supporting “hard information” search in case of search goods, such as large information quantity, multimedia, privacy, spatial and temporal characteristics, as predicted by hypotheses 4a-e. On the other hand, task technology fit can be achieved through technological characteristics supporting search of “soft information”, such as personalization, interactivity, privacy, spatial and temporal characteristics, as stated in hypotheses 4f-j. The construct of task-technology fit is determined by different sets of technological characteristics for search goods and experience goods. For search goods, information quantity, privacy and spatial characteristics are in effect ( $\beta=.68$ ,  $p<.01$ ;  $\beta=.33$ ,  $p<.01$ ,  $\beta=-.17$ ,  $p<.01$ ). Hypotheses 4a, 4c and 4e are supported, whereas hypotheses 4b and 4d are not supported by the data. For experience goods, two more characteristics besides those three are in effect (information quantity:  $\beta=.84$ ,  $p<.01$ ; privacy:  $\beta=.14$ ,  $p<.05$ ; spatial characteristics:  $\beta=-.47$ ,  $p<.01$ ), namely personalization and multimedia ( $\beta=.50$ ,  $p<.01$ ;  $\beta=-.27$ ,  $p<.01$ ). Hypotheses 4f, 4h and 4j are supported, but hypotheses 4g and 4i are not supported by the data. Out of 23 hypotheses proposed, 15 hypotheses were supported by the data.

There are three important results found in this paper: First, use intention of a website as product information search tool is influenced by, besides PU and PEOU, perceived risks and perceived search costs of the product. Second, product categorization moderates the causal relationship between use intention and its direct and indirect determinants. Third, task technology fit plays an important role in mediating the effects of technological characteristics and product information categorization onto perceptions of a Website.

### Reference

- [1] Agarwal, R. & Prasad, J. (1998) The antecedents and consequents of user perceptions in information technology adoption, *Decision Support Systems*, Vol. 22, 15-29.
- [2] Bagozzi, & Yi, (1988) On the evaluation of structural equation models, *Journal of the Academy of Marketing Science*, Vol. 16, p.
- [3] Bauer, (1960) Consumer behavior as risk taking, *Dynamic Marketing for a Changing World*, ed. By Robert S. Hancock, 189-398.
- [4] Beach & Mitchell (1978) A contingency model of the selection of decision strategies, *Academy of Management Review*, 39-49.
- [5] Beatty, S. E. and Smith, S. M. (1987) External search effort: An investigation across several product categories, *Journal of Consumer Research*, 14, June, 83-95.
- [6] Davis, F. (1989) Perceived Usefulness, perceived ease of use and user information technology, *MIS Quarterly*, 319-340.

- [7] Davis, Bagozzi & Warshaw, (1989) User acceptance of computer technology: A comparison of two theoretical models, *Management Science*, Vol. 35, No. 8, p 982-1003.
- [8] Dishaw & Strong (1999) Extending the technology acceptance model with task-technology fit constructs, *Information and Management*, Vol. 36, p. 9-21.
- [9] Dowling, G. R. & Staelin, R. (1994) A model of perceived risk and intended risk-handling activity, *Journal of Consumer Research*, 21, 119-134.
- [10] Dutta, S., Kwan, S., & Segev, A. (1998) Business transformation in electronic commerce: A study of sectoral and regional trends. *European Management Journal*, 16(5), 540-551.
- [11] Ford, G., Smith, D. B. & Swasy, J. L. (1988) An empirical test of the search, experience and credence attributes framework, in *Advances in Consumer Research*, 15, Michael J. Houston, Ed.. Association for Consumer Research, Provo, UT. 239-243.
- [12] Ford, G., Smith, D. B. & Swasy, J. L. (1990) Consumer skepticism of advertising claims, *Journal of Consumer Research*, 16, March, 433-441.
- [13] Goodhue & Thompson (1995) Task-technology fit and individual performance, *MIS Quarterly*, Vol. 19, No. 2, 213-236.
- [14] Goodhue, (1998) Development and measurement validity of a task-technology fit instrument for user evaluations of information systems, *Decision Sciences*, Vol 29, No. 1, 105-137.
- [15] Hoffman, D. L. and Novak, T. P. (1996) Marketing in hypermedia computer-mediated environments: conceptual foundations, *Journal of Marketing*, Vol. 60, 50-68.
- [16] Jacoby & Kaplan (1972) The components of perceived risk, *Proceedings of the third annual conference of the association of consumer research*, p. 382-393.
- [17] Jacoby, J. (1984) Perspectives on information overload, *Journal of Consumer Research*, 10, March, 432-435.
- [18] Johnson & Payne (1985) Effort and accuracy in choice, *Management Science*, Vol. 31, No. 4, 395-414.
- [19] Jöreskog, K.G., & Sörbom, D.(1993) LISREL 8: Structural equation modeling with the SIMPLIS command language. Chicago, IL: Scientific Software International.
- [20] Kaplan, Syzbillo & Jacoby (1974) Components of perceived risk in product purchase: A cross validation, *Journal of Applied Psychology*, Vol. 59, No. 3, 287-291.
- [21] Lin, J. CC. & Lu, H. (2000) Towards an understanding of the behavioral intention to use a web site, *International Journal of Information Management*, 197-208.
- [22] Mitchell, V. (1992) Understanding consumers' behaviour: Can perceived risk theory help? *Management Decisions*, Vol. 30, No. 3, 26-31.
- [23] Nelson, P. (1970) Information and consumer behavior, *Journal of Political Economy*, Vol. 78, 311-329.
- [24] Nelson, P. (1974) Information and consumer behavior, *Journal of Political Economy*, Vol. 81, 729-754.
- [25] Nelson, P. (1976) Economonic value of advertising, in *Advertising and Soceity*, Yale Brozen, ed., New York University Press, New York. 109-141.
- [26] Nelson, P. (1981) Consumer information and advertising, in *Economics of Information*, M. Galatin and R. D. Leiter, eds., N. Nijhoff Publishers, Boston, MA. 42-77.
- [27] Newman, J. W. (1977) Consumer external search: Amount and determinants. In A. Woodside, J. Sheth and P. Bennett (eds.) *Consumer and industrial buying behavior*. New York: Elsevier.
- [28] Palmer, J. W. & Griffith, D. A. (1998) An emerging model of website design for marketing, *Communications of the ACM*, 41, 3, 44-51.
- [29] Payne, (1982) Contingent decision behavior, *Psychological Bulletin*, Vol. 92, No. 2, 382-402.
- [30] Peterson, R. A. Balasubramanian, and Bronnenberg, B. J. (1997) Exploring the implications fo the internet for consumer marketing, *Journal of the Academy of Marketing Science*, Vol. 25, No. 4, 329-436
- [31] Ratchford, B. T. & Gupta, P. B. (1987) On measuring the informational efficiency of consumer markets, In P. Anderson and M. Wallendorf, (eds.) *Advances in Consumer Research*, 14, 309-313.
- [32] Schillewaert, N. Langerak, F. and Duhamel, T. (1998) Non-probability sampling for WWW surveys: a comparison of methods, *Journal of the Market Research Society*, Vol. 10, No. 1, 307-322.
- [33] Stigler, (1961) The economics of information, *Journal of Political Economy*, Vol. 69, 213-225.
- [34] Strader and Shaw (1997) Characteristics of electronic market, *Decision Support Systems*, Vol. 21, 185-198.
- [35] Taylor (1974) The role of risk in consumer behavior, *Journal of Marketing*, Vol. 38, 54-60.
- [36] Zigurs & Buckland (1998) A theory of task-technology fit and group support systems effectiveness, *MIS Quarterly*, 313-334

# The Customer Resource Management in the Internet Age

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## Abstract

The fiercer and fiercer competition and the change of competition model make the customer more vital than before. In order to keep up with the changing situation, the competition-orientation turns from “product-center” to “customer-center” and there appears subsequently some new ideas such as “relationship marketing”, “customer relationship management” and etc. The customers’ status has been enhanced in the web age and the old ideas about customer management become out of date. So the author presents a new idea of customer management ----- customer resource management, which requires the enterprises take the customer as their own resource and make use of this resource to get competition advantage. The paper mainly discourses the following three aspects: the evolution of customer management ideas, the strategic analysis of customer resource and the strategic value of customer resource management.

## 1. Introduction

The customers’ status is promoted gradually during the fiercer and fiercer commerce competition. Meanwhile, the competition focus turns from products to customers and what is the key—point of a enterprise’s success is the manage-skill on those recognizable customers who buy a large amount of goods at one time and transact more times. Especially when there comes the web age, the economic-running model and the competition methods both changes greatly. The main cause is consumers’ demand going quickly on that way of individuality and diversity. Internet entitles consumers the dominant power----they can get much information by means of modern technology. So, companies can’t gain the leading position unless they can satisfy consumers’ demand fastest and best. This capability is the most important competition advantage in the e-commerce. Therefore, companies must put enough emphasis on the consumer (especially those customers) study and try to improve customer management level. It is of strategic meaning to each company.

There is close connection between the development of marketing theories and customer management ideas. In 1985, Babala.Jackson put forward the concept of “Relationship marketing”. This new idea discarded the traditional idea of “transaction marketing” and denoted the marketing aim should be “trying to get、establish、maintain” the close and long-term relationship with customers. Once presented, the idea of “Relationship marketing” is popularly accepted and applied in a quite

wide range.

When time comes into 1990s, the internet-economy makes consumers a more important and active role in the e-commerce. We even can say it is consumers, not enterprises, that is the dominator now. Only trying to maintain the good relationship with customers with traditional tools (such as good product and other marketing endeavors) is hard to obtain customers or their praises, the current competition advantage is built on the capability of meeting customers’ personality-and-differentiation-demand fastest. In the web age, the unique method to gain long-time competition advantage is satisfying customers with high accuracy and rapidity; those who can’t do this will come to failure certainly. For this, there comes the new idea of “Customer relationship management” Which is based on the database technology and guided by the “one-to-one marketing” theory. “Customer relationship management” acquires demand information of customers by means of many kinds of web technology and other modern tools, such as the Emails, call-center, automation sale system and etc. Through analyzing the information having been collected by so many channels and combined with the traditional marketing instruments, “Customer relationship management” strives to supply the most rapid and excellent individualized service.

Compared to the marketing ideas based on the products and brands, “Relationship marketing” and “customer relationship management” both have great progress, but there is still much weak points in them. “Relationship marketing” regards customers as a fixed and passive factor and the quality of the “enterprise---customer” relationship which is decided by the enterprise’s endeavor in building relationship, what the customers have done and what they are doing have little influence. In other words, “Relationship marketing” treats customers as a passive receiver of all the enterprises activities; only the enterprise’s behavior can influence the relationship. This is the distinctive defect of “Relationship marketing”.

Although “customer relationship management” realized it is of great importance that customers imitatively show their demands in the process of relationship maintaining. Customers are still treated as a external factor----they are seen independent or even against to enterprises Both sides intend to gain more benefit: customers wish to meet their demand at the least cost, and enterprises wish to gain the greatest profits from customers. Obviously, the relationship built on this thought is quite unstable. Once either side can’t meet it’s own needs, it’ll be entirely hopeless in relationship

maintaining. Then, what the enterprises have done is in vain.

Furthermore, whether “Relationship marketing” or “Customer relationship management” regards the customer-satisfaction-level as a important index in evaluating the enterprise-customer relationship, and almost all the enterprises that directed by these two ideas take great endeavor in improving the customer-satisfaction-level. However, chasing only the high customer-satisfaction-level might lead enterprises to a wrong direction---there is huge difference between customer-satisfaction and customer-loyalty, and what is vital to enterprise is customer-loyalty. Firstly, the satisfied customers may not purchase from the same company again. The consumer habits, income, location and other factors will impact their consumer decisions. Secondly, enhancing the customer-satisfaction-level will expend much money and labor, but the possible end is the investment and output is more unbalanced. So, enterprises should know that the satisfied customers aren't equal to the loyal customers, and only the loyal customers are the resource of their long-term profits--they even help enterprises build their core competition advantage.

Another problem of “Relationship marketing” and “Customer relationship management” is they both think the money customers pay for the goods or serve is the most meaningful even the unique value that customers bring to them, so they ignore customers' great contribution on the many other sides.

All in all, it's necessary to put forward a new idea of customer-management in the web age. Customers should be regard as a resource and even the critical resource (or call it strategic resource) that can determine the enterprises' fate in competition, and enterprises should comprehend customers' value comprehensively and manage customers based on this. We name this new idea as “customer-resource-management”.

## 2. The strategic analysis of customer resource management

### 2.1 The strategic value analysis of customer resource basing on the resource-based theory

The resource-based theory founded by Barney, Rumelt and Peteraf is the linkage of Porter's competition advantage theory and Prahalad&Hamel's core capability theory. Resource-based theory regards the enterprise as an ensemble of all kinds of resources, including the capital, capabilities, organization process, the enterprise's characters, information, knowledge and etc. Only the critical resource but not the common resources can gain competition advantage for enterprises. The critical resource is the fountainhead of the core capability and it uplifts the enterprise to a more high revenue level (Penrose,1959).The critical resource must be of the following five characters: being valuable, being scarce, can not be completely cloned, can not be substituted by other resources、 must be obtained at a price lower than its

value(Barney,1991).The study structure of the resource-based theory is “resources → strategic → achievement”, which shows the core notion of this theory: the difference of enterprises capabilities is resulted from their strategies or furthermore , and determined by their different resources. The resources influence an enterprise strategic first, and then the competition ability. Obviously, it is just the owned resources that determine an enterprise's capability.

In the e-commerce, the material resources are easy to get, the technique can be cloned easily and its life cycle is shorter and shorter. So, it's difficult for enterprises to build the core capability on these two factors.

Contrary to these, as a resource, customer-resource totally fits for the requirement demanded by Barney and furthermore, it has more value than the common strategic resource and contribute much to the core-capability's forming and improving. So, treating customers as a critical resource and making strategies, the enterprises will do better in competition surely.

### 2.2 The strategic character of customer resource

The strategic resources are those resources, which can't realize its expected purpose unless it enhances the enterprise's capability at some sides (HengLi&YiLiu, 1996). To make full use of customer-resource, the enterprise must grasp the following strategic characters of customer quite well.

#### 2.2.1 Stability and specialty

The good relationship between customers and enterprises will erect a transferring-barrier. Customers must undertake high cost if they transfer to another enterprise. For this, customers, especially those loyal customers, once generate trust to an enterprise; they'll be the most stable resource. Study has proved that if the loyal customers increase 5%, in different industries, the profit will increase 25-95% (Reichheld, 1996). Meanwhile, except for buying repeated, the loyal customers also provide much valuable information timely. And the stability transforms into specificity in long run. It builds an entrance-barrier against the latent antagonists, which ensures the company to get the monopolized profits coming from loyal customers. It also sets a quitting-barrier to hold back the enterprise's quitting from that industry, or else it'll lose the profits could be gained from current customers and expend more on acquiring new customers. The stable customer resource also can stimulate employers to work hard for the enterprise's aim.

#### 2.2.2 Can be used repeatedly

Once be used, the majority resource's value is completely excavated and can't be used again, or their value in repeated-use is quite limited. Compare to them, the customer-resource can be used again and again, and most important, acquiring more knowledge about the whole enterprise in utilization, the customer-resource's value is added at the same time. It can generate greater

effect in the next time utilization.

### 2.2.3 Network-effect

A resource often has a single utility and can be used at one method only, but the customer-resource gives more contribution to the enterprise, in other word, we can say it has the network-effect

Customers not only bring enterprise money, they also bring much information and by which, enterprise can meet customers' need quickly and exactly. The mouth-recommendation brings many customers and even the customers' customers can become the enterprise's customers. Furthermore, forming cooperate-partnership with their customers, enterprise in finance difficulty might obtain capital from its customers. They are willing to pay for the goods beforehand, even lend money to the enterprise. Except for this, the customer-resource can be shared with other companies and the sharers all can benefit from other' customer-resource. For example, the combined sale of Coca-Cola and Pint can be seen as sharing the two companies' customer-resources, or we can call this the repeated-selling of customer-resource. So, we can say the customer-resource will generate network revenue for the enterprises.

### 2.2.4 Driving-force

Driving-force means that besides its core-value, customer-resource can push other resources turning towards strategic resources (See Figure 1). From the chart, we know that the critical resources might come from some scattered resources or innovated by modern techniques or purchased from outside. The sources' features never are unchangeable, with time flying; even the strategic resources might be less useful and turn into common resources. Customer-resource lies in all departments and all manufacture-processes, it can help enterprises evaluate, select resources and optimize its business process. Directed by customers information, the human resources, capital, materials all can be allocated effectively and realize their greatest value. Meanwhile,

the inferior resources will be discarded. In fact, the pushing-force really improves the resources' using-efficiency and then, enhances the enterprise's long-time competition capability.

### 2.2.5 Virtuality

Now, many enterprises have treated customers as their capital and evaluated it with the index of "customer-lifetime-value", which is the profit customer bringing during the whole consume-lifetime. The total profits need to be reappraised into the current value. Because the customers' consumer behavior isn't fixed in future, what we estimated now is quite possibly to change, so, the customer-capital only can be seen as artificial capital.

The same problem lies in the idea of customer-resource. First, customers' personalities, consumer-habits, interests, income, knowledge is changing continuously, especially the predilection. Second, whether the customers have the willing of offering information or not is influenced by their mentalities and technology conditions. Third, considering the ownership, the feature of virtuality is especially distinguishable. Once having got them, enterprises have the ownership of the general resources. However, similar to the human-resource, only the usufruct of customer-resource can be gained, the ownership is still belonging to the customers themselves.

Thinking of these, what the enterprise can do is treating customer-resource as an artificial resource and put enough emphasis on its changeability and virtuality.

## 3. The strategic value of practicing the customer-resource man

### agement

#### 3.1 Optimizing the organization structure and business process

Customer-resource management will help enterprise

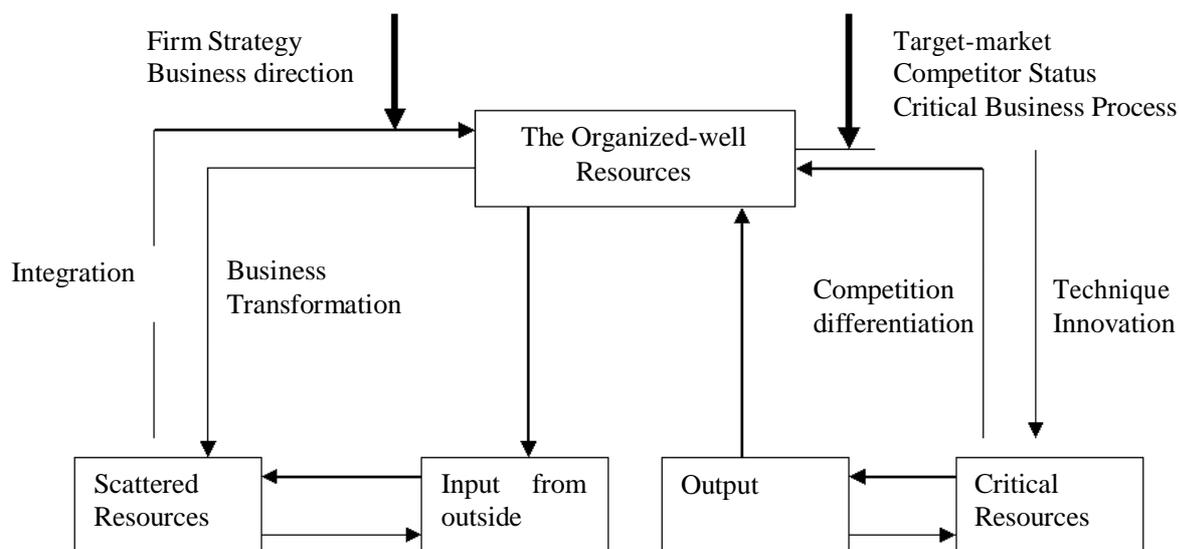


Figure 1. The process of common resources turning into critical resources

optimize its structure and business processes, and make it react to the market fast. In order to include customers into their resources and form close customer-enterprise relationship, enterprises must have the capability of collecting customers' information timely; which requires them provide convenient communication channels. So, except for realizing the manufacture and management automation, enterprises must do some adjustment to become a new flexible organization. According to this, the traditional line-produce and line-information-transferring are outdated. Manufacture and information communication should be accomplished simultaneously now, and all departments can cooperate and share information synchronously. This will improve the manufacture efficiency and management level, and most important, which will induce the beneficial circulating between structure optimizing and efficiency-improving in long-time.

### 3.2 Building and enhancing the core competition capability

The resources which can't enhance the enterprise' capability neither can generate monopoly profit nor build core competition advantage in the free competition. As a strategic resource, customer-resource has unequalled benefit on innovating technology and optimizing resources-allocation. It's useful in selecting premium resources and pushes them into valuable critical resources, which does great contribution to strengthening the core capability. Just as saying before, customers can provide market information, help resources selecting, allocating and technology innovation, optimize structure and manufacture process and etc. All these are the fountain of building and improving the core capability. Furthermore, because customer-resource is renewing and adding value to itself continuously, it causes all the activity above be carried out persistently. In this meaning, customer-resource not only from the core capability, it also improve it on and on, so, the core capability is strengthening screwing, which is the most precious situation that each enterprise chases after.

### 3.3 Strengthening the general competition advantage

The applying of customer-resource can improve the enterprise's general competition capability. Customer-resource brings direct and indirect benefits to each company. Direct benefits mainly mean customers' consume-behavior will provide money and profit. The indirect benefits are as the following: First, the information provided by customers is the most critical factor for forming competition advantage. Second, the mouth-recommendation has great influence, especial, the

loyal customers' opinions and behaviors will provide a learning-model and enlarge the customer-group (or call it customer extension). One research on 7,000 consumers in seven Europe countries has proved that relations or friends influenced more than 60% purchases (Kiely, 1993). In fact, each company can enlarge its customer-group by means of this mouth-recommendation. Third, the collaboration-relationship between customers and enterprises will prevent customers' output to other companies, or it will cost them a lot. And in order to get more from the relative enterprise; customers might be willing to help enterprise cope with all kinds of crisis, besides the finance-crisis mentioned above. For example, when enterprises are in crisis for their own mistakes, customers are easier to forgive them and the expenditure of compensating on loyal customers is much less than on the common consumers.

## 4. Conclusion

Above all, we can know that customer-resource have huge contribution to the new-product development, products (sever) sale, customer extension, enhancing intangible assets (mainly referring the brand-equity and the enterprise's image-value), collecting money, saving marketing expenditure, overcome crisis and etc. So, if any enterprise can manage and handle the customer-resource well, it'll erect a secure-effective-all-round-barrier against the antagonists, which is the source of the general competition advantage for long-time.

## References

- [1] ZhonghaiXu, from the product-life cycle to customer relationship management lifecycle the innovation of marketing ideas, *economy management*, 2001,8, 21-23
- [2] JunMa, The retrospect and consideration of the resource basis theory, *economy management*, 2001,8,34-36
- [3] GangfuWang, From competition advantage to competition advantage group, *NanKai management comment*, 2001,1,11-14
- [4] RunshengFang & HengLi, the vital resources and their forming and allocation, *NanKai management comment*, 2001,4,34-36
- [5] HuangMinxue, *Internet Marketing*, Wuhan University Press, Wuhan, 2000
- [6] Penrose E. T., *The Theory of the Growth of Firm*. Oxford: Basil Blackwell, 1995
- [7] E. Von Hippde, *The Sources of Innovation*, 1989
- [8] Porter, M. E, *Competitive Strategy*, Free Press, New York, NY, 1980

# The MTO-Framework for Implementation of E-Business Models

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## Abstract

Venture capitalists typically require that you can explain the business model in the time it takes the lift to get to the tenth floor. Implementation typically takes years. There is a disproportionate large amount of focus on what constitutes an innovative new business model compared to implementation since most e-business failures are attributed to failures in implementation. Obviously, there is a significant lack of knowledge of factors leading to successful implementation among those responsible for practical implementation of e-business models. E-business models or IT-systems for inter-organizational purposes cannot be implemented exclusively following the traditional guidelines in the IS/IT literature. Development methods are very different from earlier, there are many more stakeholders, and the environment is much more dynamic.

The paper suggests a framework highlighting important implementation factors derived from four different disciplines; venture capitalist experiences, business process reengineering, diffusion theory and system development.

The contribution of the paper is a classification of implementation factors in a framework that identifies the technological, the organizational, and the market related factors relevant for implementation of e-business models.

## 1. Introduction

The purpose of the paper is to develop an integrated approach for implementation of eBusiness models based on a taxonomy including four very different approaches to eBusiness implementation/adoption. These approaches are:

- ¾ Traditional IS/IT implementation insights especially as these was conceived until the late 80'ies.
- ¾ Business process reengineering guidelines for implementation dating from the early to mid 90'ies.
- ¾ Technology diffusion and adoption theory starting with the earlier work of Rogers, but updated in the late 90'ies with Rogers (1995), Grover et al. (1995) and Gottschalk (1999).
- ¾ Venture capital guidelines for eBusiness ventures.

It is quite clear that these approaches are very different.

There is also evidence that none of them is sufficient to secure a successful implementation. But it is our contention that each of them holds a piece of the truth.

Accordingly, the paper will contrast the four bodies of knowledge and develop a multi-perspective taxonomy for implementation of eBusiness. This will provide a basis for the development of an integrated approach in later research.

Earlier research on IT implementation is used to identify a coherent framework for eBusiness implementation factors. A number of researchers (Riggins and Mukhopadhyay, 1999; Galliers, 1999; Walsham, 2001) have pointed at the appropriateness of using past experiences from other technologies in the process of understanding new technological and managerial concepts such as eBusiness. That is especially the case for those technologies that are transferable from one environment to another (Riggins & Mukhopadhyay 1999). From a technological point of view the lessons learned from implementation of IT demonstrate similarities in relation to those challenges managers face when implementing eBusiness models in an organization. The humans inhabiting the organization do typically not change as fast as technologies and managerial concepts (Walsham 2001). The lessons learned from other research disciplines might therefore offer valuable insights to similar phenomena.

In order to present a holistic approach to implementation research, a cross-disciplinary approach is taken to illustrate those factors that have been found to influence implementation of IT in organizations.

The specific research questions that are investigated in this paper are:

- ¾ What are the key IT implementation factors in the different perspectives?
- ¾ How could the key IT implementation factors be classified in order to provide a coherent framework for eBusiness Model implementation?

The delimitation of this research is that the number of perspectives investigated are limited focusing on four specific schools of thought, and that the research takes an organizational perspective.

The organization of the paper is as follows. In Section 2 definitions of the two key terms, eBusiness models and implementation, are presented. Section 3 presents our design approach for the implementation framework. Section 4 outlines the key implementation factors derived from reviews of literature from venture capitalist sources, BPR, diffusion theory, and finally

system development. Section 5 presents our implementation framework for eBusiness models. Section 6 provides an illustrative case related to eBusiness model implementation. Section 7 is a discussion of the validity and applicability of the eBusiness implementation framework. Section 8 presents the conclusion and recommendations for future research.

## 2. Basic Definitions

This section presents our basic understanding of eBusiness models and implementation.

### 2.1 e-Business Models

Whether the company is a new venture or an established player, a good business model is essential to every successful organization (Magretta 2002). Although, a business model is regarded differently by different groups of researchers and practitioners, e.g. Mahadevan (2000), Amit & Zott (2001), Afuah & Tucci (2001), Applegate (2001), Weill & Vitale (2001), and Elliot (2002); most people regard a business model as a description of the business system identifying all essential business processes, products, services and information related to these. Moreover, a business model describes the actors contributing to the value creation of the product to the end user or customer and identifies roles and responsibilities, relationships, interactions and transactions of and between the value network actors.

In this paper we adopt the following definition of an eBusiness model: “An architecture of product, service, and information flows, including a description of the various business actors and their roles; as well as a description of the potential benefits for the various business actors, and a description of the sources of revenues”, cf. Timmers (1998:4). This definition frames the discussion of implementation factors and initiatives.

An underlying assumption of this paper is that the characteristics of eBusiness models call for research on the rethinking of the basis of implementation. Compared to earlier information systems, there are a number of reasons why traditional implementation models, theories, and methodologies do not hold any longer and a multi-perspective is called for:

- ¾ New stakeholders. Venture capitalists rather than internal business management make decisions about new systems, and their decisions are based on very different criteria from the traditional business unit manager due to limited knowledge of market, wish for fast exit strategies, etc.
- ¾ Interorganizational nature of eBusiness. eBusiness systems are inter-organizational covering multiple organizations where there are no ultimate decision maker. This requires much more

comprehensive analyses of competition, markets, value chains and networks, collaboration etc. It is not enough to have the commitment of a dedicated member of top-management.

- ¾ Time compression. Traditionally it could take years to develop IS/IT systems. Today many eBusiness systems are developed in time-slots of weeks or months.
- ¾ Iterative systems development. Waterfall and modified versions of waterfall models have given way to much more iterative systems development relying a lot on prototyping, testing and continuous development.

An illustration of the need for multi-perspective business analysis and that more stakeholders may influence the decision making of the implementation process is presented in the figure below.

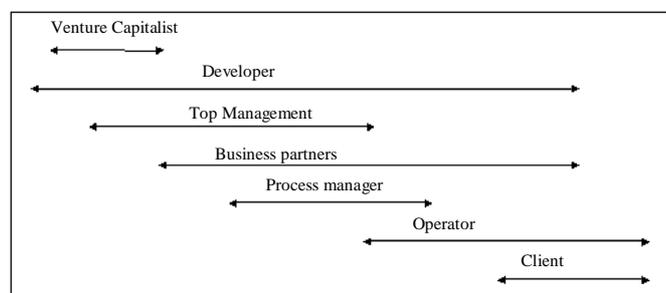


Figure 1: Overview of implementation actors during the life-cycle of an eBusiness system

Assuming that the horizontal axis represents a time scale, the figure also illustrates that the different actors in principle have different and/or overlapping time-periods in which they are actively involved in the design and implementation process.

### 2.2 Definition of Implementation

Rogers (1995) argues that the implementation stage ends when the new idea becomes an institutionalized and regularized part of the adopters ongoing operations. Any systems development project may be seen as consisting on three rather different sets of activities, requirement specifications, design and implementation. But implementation is not a particular stage occurring after a design stage. Instead we subscribe to the view that implementation is a set of activities starting almost at the very beginning of any eBusiness project and continues as Rogers suggests above, until the solution has been adopted and fully integrated not just in the target organization developing the eBusiness solution, but also for everybody else in the value network related to and affected by the solution. This is illustrated in the figure below.

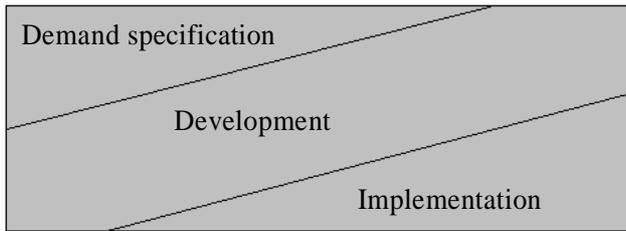


Figure 2. The Process of Organizational Implementation

The horizontal axis represents development in time, whereas the vertical axis represents the amount of efforts dedicated to particular activities, i.e. demand specification, development and implementation.

Common for almost all conceptualizations of the term implementation is that some degree of organizational action has taken place. This requires different degrees of commitment and large variety actions until the intended benefits are being realized as a successful implementation (Gottschalk, 1999).

Inherently we assume that the outcome of implementation is successful (for a thorough literature review on implementation success measures see Linton, 2002) and that it is possible to identify dependent variables for successful implementation as frequently done in the requirement specification stage. DeLone and McLean (1992) found that the most common IS implementation success factors were system usage and user satisfaction, but these are clearly too limited when considering eBusiness systems, where adoption by other organizations in the value network is of key importance. Indicators like number of visits to web-sites, revenue, execution etc. are other key performance indicators crucial to implementation success in relation to eBusiness models.

Linton (2002) found in his review of ten years of implementation literature that implementation success could be traced back to five factors: organizational structure, technology, project management, divisibility, and social interactions. The interaction perspective is especially important and has been center stage for many implementation researchers. For example Tornatzky and Fleischer (1990) claim that implementation success can be assessed by the degree of interaction with other technologies within the organization. That is especially the case when considering implementation of eBusiness models in existing organizations where the integration of eBusiness models with existing ERP-systems are of great importance if organization are to derive benefit from their eBusiness solutions. Furthermore, the integration with systems in other organizations and between organizational units in the different organizations is absolutely necessary for the success of an eBusiness.

### 3. Methodology for developing the implementation framework

The purpose of this section is to present how factors are

derived from literature, how the factors are selected and clustered, and finally how the framework is constructed.

The overall research task of this paper is, as previously mentioned, a cross-disciplinary analysis of implementation factors. The relevant implementation factors are derived through a literature review of the four influential areas of expertise/research: Venture capitalists experiences, business process reengineering (BPR), diffusion theory, and systems development. From articles within these four areas, the individual implementation factors are selected if they have been suggested as normative implementation characteristics, and are cited within the body of knowledge of the specific expertise/research area.

The implementation factors are then compared across the four areas and identical factors are eliminated and only presented once. All factors are then clustered into groups of factors with similar characteristics in order to provide an overview.

Hence, the factors are presented in a matrix presenting the various expertise/research areas. This matrix provides the basis for the resulting implementation framework where technological, organizational and market clusters represent our clustering of the factors. This framework is provided in Section 5 and show the four reference disciplines side by side and structured according to the three clusters.

### 4. Contributions of implementation factors from the literature review

This section investigates literature and practice that provides evaluation aspects of eBusiness models.

#### 4.1 Contributions of implementation factors from venture capitalists experiences

The contribution from venture capitalists to eBusiness projects has flourished especially during the dot-com period and have increased dramatically in numbers during the last 5 years. Venture capitalists (VC) have always belonged as an integrated part of the financial sector which is reflected in the implementation factors they emphasize.

Little research literature prescribe the prerequisites demanded from the venture capitalists, although general guidelines on what incubators and venture capitalists may offer of services is found in literature, cf. Hansen et al. (2000). Hence, insight from venture capitalists are found from alternative sources.

A typical example of a VC inspired insight was provided by T. Forcht Dagi (2001), MD of Cordova Ventures and professor at The Georgia Institute of Technology who shared a seminar at the Global e-Management MBA Program. The main focus of this was management, other investors, and the board. In addition to this, products/services, the market, the revenue model, the sustainable competitive advantage, the organizational structure, and the exit potential opportunities influenced this decision to invest.

Mr. Dagi argued that the pitfalls that led many start-up

companies to fail were numerous and caused by wrong interpretations and insufficient planning and analysis of the eBusiness model. Among others the true costs of starting and running business were not understood, especially since the eBusiness market suffered from weak barriers to entry. The Internet does not per se provide any sustainable competitive advantage, and customers may to a large extent be reluctant to purchase due to security issues, over-exposure, and the non-pleasant customer experience. Furthermore, revenue models were often flawed, cash flow from financing eclipsed cash flow from operations, and business plans had poor strategic vision. Hence, the success factors of an eBusiness plan promising a successful implementation are that the basic principles of business do not change, since:

- ¾ Cash flow determines survival management
- ¾ Strategy and vision are key attributes
- ¾ Growth is to be obtained organically or by acquisition
- ¾ A solid understanding of what really drives customer value is necessary
- ¾ A rational revenue model is required.

Noble (1999) suggests a model that divides an implementation into four stages. The stages are pre-implementation, organizing the implementation effort, managing the implementation process, and maximizing cross-functional performance. The focus of the model is on cross-functional issues and dynamics. This is why it is relevant to consider in relation to implementation of eBusiness models, which contain the same characteristics. The research of Noble (1999) provides critical success factors (CSF's) for each implementation stage from a managerial point of view. The "managerial levers", cf. Noble (1999:25), as the CSF's are named, provide insight from a research conducted through executive interviews and middle manager surveys with respect to goals, organisational structure, leadership, communications, and incentives. The learning point of the framework provided is that the management of these factors changes through the implementation stages.

Lazer & Livnat (2001) suggest a five-step evaluation process of eBusiness models that is materialised in specific questions regarding the economic viability of the eBusiness model. These are:

- ¾ What market failures and transaction costs are addressed by the business model?
- ¾ How effective can the e-commerce firm be in reducing the market failures or transaction costs?
- ¾ Will the e-commerce company be able to expropriate benefits from customers?
- ¾ What are the necessary resources to conduct the business?
- ¾ Can competitors erode profits?

The transaction costs address in particular seller's

transactions costs of order taking costs, recording costs, display costs, mailing costs, and marketing costs; buyer's transactions costs of transportation costs, timing of transactions, information gathering costs, information processing costs; and other benefits as personalization, price transparency, market making, and network externalities.

De et al. (2001) suggest a micro economic perspective on evaluating eBusiness models emphasizing traditional areas as transaction costs, switching costs, network externalities and product versioning. In addition to this the authors suggest that successes and failures of eBusiness models also need to be evaluated based on infrastructure investment models, user experience models, and models for revenue generation in order to reveal the inherent complexity of conducting electronic business.

#### 4.2 Contributions of implementation factors from BPR

The concept of Business Process Reengineering (BPR) was originally coined by Hammer (1990). The focus here was very radical emphasizing radical organizational changes through obliteration of activities instead of (or before) automating the activities. The approach was later softened and changed focus from radical redesign to process focus as the driving force in reengineering projects, cf. (Hammer 1996, Hammer 1999). The reengineering activities have during the early years primarily addressed intra-organizational initiatives, cf. e.g. Hammer & Stanton (1995) and Keen (1997), but has later extended the scope to network redesign by focusing on inter-organizational redesign projects, e.g. Keen & McDonald (2000) and Hammer (2001).

One of the key issues in implementing BPR projects according to Hammer & Champy (1993) is that reengineering success depends on getting all the way around the business system diamond (Hammer & Champy 1993; Champy 1995) meaning that not only design decisions must be taken, but also that deployment must be conducted. The business system diamond identifies the relationship between business processes, jobs and structures, management and measurement systems, and values and beliefs. When restructuring the business process, the content of jobs and of organisational structures changes for all employees. Changing jobs and structures require changes in management principles and performance measurement systems. These new management principles and performance measurement systems induce change in values and beliefs, which in turn enable the new business processes. Consequently, reengineering is not complete until all elements of the business system diamond have been changed and aligned (e.g. Larsen & Leinsdorff 1998), which is a process that may be undertaken iteratively in order to gain the buy-in, acceptance and appreciation from the employees involved (Larsen & Bjørn-Andersen 2001)

Moreover, alignment of the business processes with the business strategy is considered important (Tinnilä 1995;

Clemons et al. 1995; Sarkis et al. 1997; Lockamy & Smith 1997) as well as alignment with the information technology strategy. Hence, recruitment of the necessary skill-base and training are vital for BPR-project success, cf. Bashein et al. (1994) and Martinez (1995). In addition to this, scoping the BPR-projects (Hall et al 1993) and assuring learning processes (Galliers 1997) and shared values (Grover et al. 1995) are crucial for obtaining radical results. Finally, change management emphasizing communication and training and handling of political controversies are important in order to maneuver in a highly political landscape which a BPR project often turns into, are recommendations from researchers as well as practitioners (McElrath-Slade 1994; Taylor 1995; Davenport 1995; Homa 1995). Finally, most authors agree that all BPR efforts are unlikely to reach success unless the top management is committed, supported and engaged in the activities (e.g. Davenport & Short 1990; Bashein et al. 1994; Willcocks & Smith 1995).

#### 4.3 Contributions of implementation factors from diffusion theory

The traditional diffusion of innovations theory as represented by Rogers (1995) assumes that implementation is the final destination of a sequential process departing from initiation of a given idea. The IT diffusion process is characterized by different behaviors. Whereas the adoption stage is claimed to represent rational behaviors, the implementation stage is argued to reflect social learning and political behaviors (Cooper & Zmud, 1990). The final stage in the implementation process is routinizing. This routinizing is characterized by a combination of individual and organizational learning where individual insights and skills become embodied in organizational routines (Attewell, 1992).

The diffusion theory is not specifically targeted at adoption, implementation, and diffusion of IT. The theory is relevant to any technological innovation, which is implemented among individuals and organizations. Researchers within MIS (e.g. Premkumar et al., 1994; Ramamurthy et al., 1999; Ramamurthy & Premkumar, 1995; Cooper & Zmud 1990) have however often used the perspective when defining normative guidelines for successful implementation of IT. These sources are used as guidance for description of the key factors influencing successful IT implementation in organizations from a diffusion perspective.

According the diffusion school of thought implementation is when a new practice is put into use (Marble, 2000). Implementation therefore involves behavior change in the organization (Rogers, 1995). A more specific definition targeting organizational IT implementation is given by Kwon and Zmud who claim that organizational IT implementation is “the managerial concerns focusing on the effective diffusion of information technologies into organizations, business units, and work groups” (Kwon & Zmud, 1987). Cooper and Zmud (1990) defined IT implementation as “an organizational effort

directed toward diffusing appropriate information technology within a user community.” The means for “the diffusion of information technology” according to this line of thought are presented in the following.

The factors influencing implementation represent a broad variety of themes. Researchers within diffusion theory have presented useful classifications of the numerous factors (e.g. Kwon & Zmud, 1987; Tornatzky & Fleischer 1990; Premkumar & Ramamurthy, 1995). In this context the Kwon and Zmud (1987) taxonomy is used as a classification scheme. The reason for using this particular classification of contextual factors influencing implementation is that a broad scope of factors influencing organizational implementation is included. Five types of factors are identified in the Kwon and Zmud taxonomy: 1) Characteristics of the user community influencing implementation, e.g., commitment to change, education, social approval, degree of understanding of the technology. 2) Characteristics of the organization influencing implementation, e.g., organizational structures, management support, organizational compatibility. 3) Characteristics of the technology influencing implementation, e.g., degree of complexity, compatibility, standards. 4) Characteristics of the task to which technology is applied influencing implementation, e.g., task uncertainty, responsibility, task variety. 5) Characteristics of the organizational environment, e.g., uncertainty, dependence, and power.

#### 4.4 Contributions of implementation factors from system development

The system development perspective sees implementation as the last step in the development life cycle. It is “the conversion and installation of newly developed systems” (Marble 2000). From the system development perspective systems success can be measured by four parameters (Coe, 1996): Use of the system measured by intended or actual use of the system; Favorable attitudes toward the system on part of users; Degree to which the system accomplishes its original objective, and; Payoff to the organization. These measures are closely related to successful implementation. However, as pointed out by Coe (1996) numerous implementation efforts related to information systems are technical successes but at the same time organizational failures.

In the systems development perspective the development process is the focal point rather than the outcome and ultimately an organizational implementation success. However, at the end of the day “[Computer professionals] develop and maintain computer systems for others to use” (Dahlbom & Mathiassen, 2000). In this context we are more interested in the use than the development and maintenance of the eBusiness applications. Therefore, focus is on those factors which systems development literature identifies as important parameters for use and/ or implementation.

An organizational oriented view on systems development is put forward by Eason (1988) and by

Tornatzky and Fleischer (1990). According to them focus is on the organizational change caused by information technology. The organizational perspective to system development suggests that issues such as: testing and validating the technical system; organizational change; acceptance of change; integration with other systems and, training and support are crucial in implementing IT in organizations. These aspects indicate that implementation of IT is an organizational adaptation and learning process where the significance of technology is de-emphasized in favor of human/organizational aspects. This is in line with suggestions from other researchers, e.g. Attewell (1992). Regardless of the six steps an implementation strategy has to be considered. Basically the implementation strategy ranges from revolution to evolution (Eason, 1988). Eason argues that adaptation tends to be more difficult the less evolutionary the implementation strategy is.

Another view on implementation from a system development perspective, which is more focused on the system, is presented by (Dahlbom & Mathiassen 2000). Dahlbom and Mathiassen suggest that a set of quality parameters concerning the fulfillment of users objectives are necessary for implementation. These parameters include: Correctness, reliability, efficiency, integrity, and usability. This view of system efficiency as a parameter for successful implementation is also suggested by (Coe 1996) who argues that system failure can be avoided by observance of five efficiency measures related to systems delivery; implementation process owner, training, front line support, explication of efficiency measures, and effective communications. Finally, Iversen et al. (2001) advocate the importance of risk management during the implementation process.

## 5. Construction of the implementation framework

This section describes how the factors of the different perspectives are clustered and the basis for this clustering.

Based on the literature reviews of the four reference disciplines all factors were individually put on a blackboard in order to get an overview. Then identical factors within the same reference discipline were eliminated. A clustering of the factors were then undertaken through a iterative process of trying to identify a common denominator of the clusters. The final clustering process resulted in three clusters, i.e. Technological factors, Market factors and factors Organizational – in short the TMO-framework. The table below is the result of the clustering process.

As illustrated in Table 1 do all four disciplines have strong emphasis on organizational factors. Some of these factors which are represented in all four disciplines is management support and organizational structure, directly related to commitment to change. The diffusion theory and systems development literatures do not focus on marked factors in particular. This has been source to recent criticism (Lyytinen & Damsgaard, 2001; Kurnia & Johnston, 2000) since it narrows the scope of diffusion

theory in relation to IOS. The technological cluster is represented in all four disciplines. However, focus is very different depending on the school of thought. Whereas diffusion theory and system development literature focus on manifest attributes of the technological artifact, VC and BPR focuses on more abstract characteristics related to the capabilities of the technology.

Implementation factors from the four perspectives are clustered or related to technology, market, or organization – see appendix.

## 6. The HABURI.COM case

The case presentation of HABURI.COM is provided to illustrate the broad range of implementation issues businesses are confronted with when applying an eBusiness model in their business practices. The presentation of HABURI.COM is mainly based on Bjorn-Andersen (2002).

HABURI.COM is a virtual factory outlet mall for fashion clothing and accessories on the Internet. The HABURI site was first launched by April 2000 and by the end of year 2000 the company was present in fifteen European countries. Before the launch of the virtual factory outlet mall the three founders investigated the characteristics of physical factory outlets. They found that the virtual outlets had a number of advantages compared to the physical outlets. These advantages included elimination of distance to outlet for customers and critical mass among customers due to a general increase in the number of factory outlets. Taking the critical situation at that time into consideration HABURI was fortunate to get the necessary financial support when they searched for investment capital in beginning of year 2000. It took the founders 180 days from the strategy formulation and till the web-site was launched. The founders reason this successful entry by their professional preparations, operations and well-stated business plan.

Prior to the launch of the web-site the three founders of the company made a rough draft of HABURI's business strategy. Part of the business strategy was to meet the customers' expectations rather than to present the ultimate eBusiness solution from day one. The strategy for the web-site was to create a web-site without any complex user-intrusive technologies. Next, part of the business plan was, as explicitly pronounced in the firm's mission statement, to stick to one of the old business virtues: Placing the customer in focus. Another strategic consideration was to differentiate HABURI from traditional online retailing shops. Two features distinguish HABURI from traditional online retailing shops. Firstly, HABURI sells the most exquisite brands on the market through their web-site. By year 2000 DKNY, Calvin Klein, Cerrutti, and Valentino were some of the organizations supplying products to the HABURI web-site. The online retailing clothing store thereby differentiates it from for example landsend.com or dressforless.com. Secondly, instead of selling from stock as the traditional online clothing shops HABURI decided to prosper from their

competitors' failure in estimating demand. The primary approach is to clear the its suppliers' stock. It is traditionally critical for producers of exclusive brands to sell their stock through clearance sales in the traditional channels since those customers, which bought their clothing do not like to see their luxury goods being offered in less exclusive environments.

HABURI did from day one decide to outsource several activities. Though the three founders had business backgrounds and experiences in the Internet environment they realized it was crucial to obtain expert knowledge in different areas. McKinsey & Company contributed with knowledge in the pre-launch phase by giving input to the business strategy. IBM Denmark and ProActive A/S delivered the technical eBusiness platform to the web-site. Proffice Communication Center A/S designed and composed the HABURI web-site. It was made as customized as possible in order to increase the customer service level. Proffice Communication Center A/S was also in charge of the call-center functions and information services. Finally, did the SAS Institute provide a business intelligence system, Balanced Scorecard, which was implemented in order to assist the decision-makers in establishing strategic decisions. The Balanced Scorecard solution was used to prepare distribution, logistics and customer contact.

It was HABURI's strategy to create a reintermediating link in the supply chain. This strategy has far proven to be successful. Downstream in the supply chain HABURI has created a window of opportunities for customers to make a good bargain on exclusive clothing and accessories. Upstream in the supply chain HABURI has created a safe market-place for the exquisite brand names to clear their stock. HABURI is as such an example of a successful implementation of an eBusiness model.

## 7. Discussion

The validity and applicability of a framework is of particular importance as it is suggested to serve as recommendations and guidelines for future ventures implementing eBusiness models either as click-and-mortar or pure-e-play initiatives. Hence, the robustness of the proposed framework is discussed in the following.

Depending on the choice of eBusiness model definition, variations of relevant factors may change. However, as the majority of the definitions referred to in the eBusiness model section are comparable with the selected definition of Timmers (1998), the likely variations in the proposed framework are expected to be moderate. Similarly, the choice of relevance criteria for selecting implementation factors may provide some variation in the final outcome of the framework.

Literature, either providing prescriptive recommendations or descriptive experiences, suggests a huge number of factors that likely may affect implementation of information systems and eBusiness models in particular. In our presentation of relevant factors we have aimed at selecting factors the commonly were

agreed as important, although this selection process may be influenced by subjective opinions. We did find that an implementation model for eBusiness models should include three clusters of factors: technology, market, and organization – the TMO-model. Depending on the theoretical perspective emphasis varied on the three dimensions. However, given our multi-disciplinary approach it is concluded that a feasible model for eBusiness model implementation should embrace the three dimensions.

The framework may have leveraged other categorization schemes, which could have altered the final presentation of the implementation framework. E.g. Earle & Keen (2000) identify six value drivers that are crucial for long-term profitability of eBusiness models. The value drivers that are derived from field research and the authors' experience in companies (as president of Hewlett-Packard E-Services Solutions and Chairman of Keen Innovations) are logistics, relationships, channels, branding, capital and cost structures, and intermediation. Through these drivers the authors claim that the primary goal of any business, which is to create customer value and generate profits over the long term, may be obtained.

As mentioned in Section 3, this work is considered to be conceptual in nature. Based on a review of four relevant research disciplines we have outlined a theoretical framework, which we find broadly applicable for eBusiness model implementation. One way of validating a theoretical framework is to validate the strength of the theoretical contribution. Whetten (1989) has outlined four guidelines for assessment of theoretical contributions: 1) A description of which elements logically should be considered as part of the explanation of the social or individual phenomena of interest; 2) A description of the relationship between the elements; 3) An explanation of the underlying psychological, economic, or social dynamics that justify the selection of elements and the proposed causal relationships, and; 4) A description of the range of the theory. These four "building blocks" will be discussed to demonstrate the strength of eBusiness model implementation framework.

The first building block defined by Whetten reflects the factors, which are part of a given model. In our TMO-model we argue that technology, market, and organization are the factors which should be considered as parts of the phenomena. Our phenomenon, which is to be embraced by the TMO-model is eBusiness model implementation success. The just described example of HABURI.COM illustrates the validity and applicability of the model. The three founders paid interest to the development of the web-site and the technical platform. They argued that technology had to be efficient and user friendly. The founders also paid attention to market factors. HABURI.COM focused on customers and they did at the same time provide an optimal solution for their suppliers by creating a reliable outlet for their potential suppliers. The organizational factors are indirectly represented in the HABURI.COM case. It is evident that the management supported the adoption and implementation of the

eBusiness model since they were the designers of the concept. It is also evident that there would be no resistance to change in the organization since no rigid structures had been established in the start-up venture. However, aspects related to e.g. organizational learning and competence building did get attention from the founders. HABURI.com did explicitly engage Proofoffice Communication Centre A/S to manage these tasks.

The second building block, which focuses on the relation between the elements, is also well illustrated in the HABURI.COM case. The founders integrated the three dimensions technology, market, and organization in their business-strategy. Whetten suggests that some causality should be probable from the relationships between the included dimensions of the model. The founders of HABURI.COM realized that the technological dimension had to include certain attributes in order to support their market relations and at the same time support organizational structures.

The third building block is concerned with the underlying logic of the model. As described in Section 2.1 do we find that eBusiness models are characterized by attributes, which go beyond the organization. Value is created in networks and the market dimension is therefore an important aspect, which has to get attention when outlining normative guidelines for implementation. Inherent in eBusiness models is technology (Timmers, 1998). It is therefore inevitable to include the technological dimension in a framework, which aims at supporting successful implementation of eBusiness models.

The fourth building block, which can be used to assess the validity of the theoretical contribution, is concerned with the range of the theory. Those eBusiness models which are based on business-to-business relations and market structures (versus hierarchical structures) make a natural scope of the model.

## 8. Conclusions and Future Research

The paper argues that the prerequisites for implementation of eBusiness models compared with traditional information systems are changed due to causes as new stakeholders, need for multi-perspective business analysis, time compression of development time and changed development methods. Hence, it is relevant to suggest a framework highlighting important implementation factors derived from various relevant disciplines.

The specific research questions investigated in this paper are: What are the key IT implementation factors in different perspectives? And: How should the key IT implementation factors be classified in order to provide a coherent framework for eBusiness Model implementation?

The key IT implementation factors of each of four influential areas of expertise/research, i.e. venture capitalists experiences, BPR, diffusion theory, and systems development, were presented based on a literature review.

The implementation factors were classified in a framework – the TMO-model - that identified the technological, the organizational, and the market related factors relevant for implementation of eBusiness models.

The framework may be extended in various ways. More perspectives may be investigated and searched for contributing eBusiness model implementation factors. Also development direction of the research is that the framework may be tested under different conditions. For example, case studies may be performed using the framework as a diagnostic tool or surveys covering a larger number of business models may be conducted. All initiatives will add to the development and robustness of the framework by increasing the validity of the framework. Moreover, research will be conducted in development of assessment criteria for evaluation of eBusiness models, systems and application in order to assure the implementation process. Empirical testing of the framework is optimally performed on a sample of eBusiness models from different organizations that will provide statistically validated results. However, at the research is in its embryonic stage such a high validation level have not been possible to reach.

## References

- [1] Afuah, A. & Tucci, C.L. (2001). *Internet Business Models and Strategies: Text and Cases*. Boston, Mass.: McGraw-Hill Irwin.
- [2] Amit, R. & Zott, C. (2001). Value Creation in E-Business. *Strategic Management Journal*. Vol. 22, pp. 493-520.
- [3] Applegate, L.M. (2001). *E-Business Models: Making Sense of the Internet Business Landscape*. Chapter 3 in Dickson, G.W. & DeSanctis, G. (Eds.) (2001). *Information Technology and the Future Enterprise: New Models for Managers*, Upper Saddle River, N.J.: Prentice Hall.
- [4] Attewell, P. (1992) *Technology Diffusion and Organizational Learning: The Case of Business Computing*. *Organization Science* 3, 1-19.
- [5] Bashein, B.J. & Markus, M.L. & Riley, P. (1994). *Preconditions for BPR Success - And How to Prevent Failures*. *Information Systems Management*, Spring, 7-13.
- [6] Champy, J. (1995). *Re-engineering Management*. Nicholas Brearley, London.
- [7] Clemons, E.K. & Thatcher, M.E. & Row, M.C. (1995). *Identifying Sources of Reengineering Failures: A Study of Behavioral Factors Contributing to Reengineering Risks*. *Journal of Management Information Systems*, 12(2), Fall, 9-36.
- [8] Coe, L.R. (1996) *Five Small Secrets to Systems Success*. *Information Resources Management Journal* 9, 29-38.
- [9] Cooper, R.B. & Zmud, R.W. (1990). *Information Technology Implementation Research: A*

- Technological Diffusion Approach. *Management Science*. Vol. 36, no. 2, February.
- [10] Dagi, T.F. (2001). E-Business and the Venture World of 2001. Cordova Ventures and The Georgia Institute of Technology. Presentation at the Global E-Management MBA Seminar. Atlanta, Georgia, USA.
- [11] Dahlbom B. & Mathiassen L. (2000) Computers in Context - The Philosophy and Practice of Systems Design. Blackwell Publishers Inc., Oxford.
- [12] Davenport, T.H. & Short, J.E. (1990). The New Industrial Engineering: Information Technology and Business Process Reengineering. *Sloan Management Review*, 31(4), Summer, 11-27.
- [13] DeLone, H.W. & McLean, R.E. (1992) Information Systems Success: The Quest for the Dependent Variable. *Information Systems Research* 3, 60-95.
- [14] De, R., Mathew, B. & Abraham, D.M. (2001). Critical Constructs for Analyzing E-Businesses: Investment, User Experience and Revenue Models. *Logistics Information Management*. Vol. 14, No. 1/2, pp. 137-148.
- [15] Earle, N. & Keen, P.G.W. (2000). From .com to .profit: Inventing Business Models That Deliver Value and Profits. San Francisco: Jossey-Bass.
- [16] Eason, K. (1988) Information Technology and Organisational Change. Taylor & Francis Inc., London.
- [17] Elliot, S. (2002), Electronic Commerce: B2C Strategies and Models, Chichester, U.K.: John Wiley.
- [18] Galliers, R.D. (1999) Towards the Integration of E-business, Knowledge Management and Policy Considerations within an Information Systems Strategy Framework. *Journal of Strategic Information Systems* 8, 229-234.
- [19] Galliers, R.D. (1997). Against Obliteration – Reducing Risk in Business Process Change, 169-186. In Sauer et al. (1997).
- [20] Ginzberg, M.J. (1981). Early Diagnosis of MIS Implementation Failure: Promising Results and Unanswered Questions. *Communications of the ACM*. Vol. 27.
- [21] Gottschalk, P. (1999a). Strategic Information Systems Planning: The IT Strategy Implementation Matrix. *European Journal of Information Systems*. Vol. 8, Iss. 2, pg. 107, 12 pgs
- [22] Gottschalk, P. (1999b) Content Characteristics of Formal Information Technology Strategy as Implementation Predictors in Norwegian Organizations. *Scandinavian Journal of Information Systems* 11, 73-96.
- [23] Grover, V., Jeong, S.R., Kettinger, W.J. & Wang, S. (1995). The Implementation of Business Process Reengineering. *Journal of Management Information Systems*, Summer, 12(1), 109-144.
- [24] Hall, G., Rosenthal, J. & Wade, J. (1993). How to Make Reengineering Really Work. *Harvard Business Review*, November-December, 119-131.
- [25] Hammer, M. & Champy, J. (1993). *Reengineering the Coopertion - A Manifesto for Business Revolution*. Nicholas Brealey Publishing.
- [26] Hammer, M. & Stanton, S.A. (1995). *The Reengineering Revolution*. Harper Business.
- [27] Hammer, M. (1996). *Beyond Reengineering*, Harper Business.
- [28] Hammer, M. (1990). *Harvard Business Review*
- [29] Hansen, M.T., Chesbrough, H.W., Nohria, N. & Sull, D.N. (2000). Networked Incubators: Hothouses of the New Ecomomy. *Harvard Business Reivew*. September-October, pp. 74-83.
- [30] Homa, P. (1995). Business Process Reengineering – Theory- and Practice-based practice. *Business Process Reengineering & Management Journal*, 1(3), 10-30.
- [31] Iversen, J., Mathiassen, L. & Nielsen, P.A. (2001). Risk Management in Process Action Teams. In: L. Mathiassen, J. Pries-Heje and O. Ngwenyama (Eds.), (2001). *Improving Software Organizations – From Principles to Practice*. Addison-Wesley.
- [32] Keen, P.G.W. & McDonald, M. (2000). *The eProcess Edge: Creating Customer Value & Business in the Internet Era*. McGraw-Hill.
- [33] Keen, P.G.W. (1997). *The Process Edge Creating Value Where It Counts*. Harvard Business School Press.
- [34] Kurnia, S. & Johnston, R.B. (2000) The Need of a Processual View of Inter-organizational Systems Adoption. *Journal of Strategic Information Systems* 9, 295-319.
- [35] Kwon T.H. & Zmud R.W. (1987) Unifying the Fragmented Models of Information Systems Implementation. In: *Critical Issues in Information Systems Research*, R.J.Boland and R.A.Hirschheim (ed), pp. 227-251. John Wiley & Sons Ltd..
- [36] Larsen, M.H. & Bjørn-Andersen, N. (2001). From Reengineering to Process Management – A Longitudinal Study of BPR in a Danish Manufacturing Company. In *Proceedings of the 34th Hawaii International Conference on System Sciences (HICSS 34)*. January 3-6, 2001, Island of Maui, Hawaii, USA.
- [37] Larsen, M.H. & Leinsdorff, T. (1998). Organisational Learning as a Test-Bed for Business Process Reengineering. *Proceedings of the 31st Hawaii International Conference on System Science (HICSS'98)*, January 6-9, The Big Island of Hawaii, Hawaii, USA. Vol. 5, pp. 343-354.
- [38] Lazer, R. & Livnat, J. (2001). E-Commerce: Business Models that Make Economic Sense. Working paper. New York University. Leonard N. Stern School of Business.
- [39] Leavitt, H.J. (1965). Applying Organizational Change in Industry: Structural, Technological, and Humanistic Approaches. In *Hand book of Organizations*. Edited by James G. March, Chicago:

- Rand McNally (1965).
- [40] Linton, J.D. (2002) Implementation Research: State of the Art and Future Directions. *Technovation* 22, 65-79.
- [41] Lockamy, A. III & Smith, W.I. (1997). A Strategic Alignment Approach for Effective Business Process Reengineering: Linking Strategy, Processes and Customers for Competitive Advantage. *International Journal of Production Economics*. 50(2-3), 141-153.
- [42] Lyytinen, K. & Damsgaard, J. (2001) What's Wrong with the Diffusion of Innovation Theory? Diffusing Software Product and Process Innovations. Proceedings at IFIP TC8 W.G 8.6, fourth working conference, April 7-10 2001, Banff, Canada. 173-190.
- [43] Magretta, J. (2002). Why Business Models Matter. *Harvard Business Review*. May, pp. 86-92.
- [44] Mahadevan, B. (2000). Business Models for Internet-Based E-Commerce: An Anatomy. *California management Review*. 42(4), Summer, pp. 55-69.
- [45] Marble, R.P. (2000) Operationalising the Implementation Puzzle: An Argument for Eclecticism in Research and in Practice. *European Journal of Information Systems* 9, 132-147.
- [46] Martinez, E.V. (1995). Successful Re-engineering demands IS/Business Partnership. *Sloan Management Review*, Summer, 51-60.
- [47] McElrath-Slade, R. (1994). Caution: Re-engineering in Progress. *HR Magazine*, 39(6), 54-57.
- [48] McManus, J.J. (1995). An Implementation Guide on How to Re-engineer Your Business. Stanley Thornes.
- [49] Motwani, J., Mirchandani, D., Madan, M. & Gunasekaran, A. (2002). Successful Implementation of ERP Projects: Evidence from two Case Studies. *International Journal of Production Economics*. Vol. 75, pp. 83-96.
- [50] Noble, C.H. (1999). Building the Strategy Implementation Network. *Business Horizons*. November-December, pp. 19-28.
- [51] Premkumar, G. & Ramamurthy, K. (1995) The Role of Interorganizational and Organizational Factors on the Decision Mode for Adoption of Interorganizational Systems. *Decision Sciences* 26, 303-336.
- [52] Premkumar, G., Ramamurthy, K., & Nilakanta (1994) Implementation of Electronic Data Interchange: An Innovation Diffusion Perspective. *Journal of Management Information Systems* 11, 157-177.
- [53] Ramamurthy, K. & Premkumar, G. (1995) Determinants and Outcomes of Electronic Data Interchange Diffusion. *IEEE Transactions on Engineering Management* 42, 332-351.
- [54] Ramamurthy, K., Premkumar, G., & Crum, M. (1999) Organizational and Interorganizational Determinants of EDI Diffusion and Organizational Performance: A Causal Model. *Journal of Organizational Computing and Electronic Commerce* 9, 253-285.
- [55] Raymond, L. (1990). Organisational Context and Information System Success: A Contingency Approach. *Journal of Management Information Systems*. Vol. 6, no 4, Spring.
- [56] Riggins, F.J. & Mukhopadhyay, T. (1999) Overcoming EDI Adoption and Implementation Risks. *International Journal of Electronic Commerce* 3, 103-123.
- [57] Rogers, E.M. (1995) Diffusion of Innovations. The Free Press.
- [58] Sarkis, J., Presley, A. & Liles, D. (1997). The Strategic Evaluation of Candidate Business Process Reengineering Projects. *International Journal of Production Economics*. 50(2-3), 261-274.
- [59] Sauer, C. & Yetton, P.W., (1997). Steps to the Future – Fresh Thinking on the Management of IT-Based Organizational Transformation, Jossey-Bass Publishers, San Francisco.
- [60] Timmers, P. (1998). Business Models for Electronic Markets. In: Gadiet, Yves; Schmid, Beat F.; Selz, Dorian: EM - Electronic Commerce in Europe. EM – Electronic Markets, Vol. 8, No. 2.
- [61] Tinnilä, M. (1995). Strategic Perspectives to Business Process Redesign. *Business Process Re-engineering & Management Journal*, 1(1), 44-59.
- [62] Tornatzky L.G. & Fleischer M. (1990) The Process of Technological Innovation. Lexington Books.
- [63] Walsham, G. (2001) Making a World of Difference IT in a Global Context. John Wiley and Sons, Chichester.
- [64] Ward, J.A. (1995). Project Pitfalls. *Information Systems Management*, 12(1), Winter, 74-76.
- [65] Weill, P. & Vitale, M.R. (2001). Place to Space: Migrating to eBusiness Models. Boston, Mass.: Harvard Business School Press.
- [66] Whetten, D.A. (1989) What Constitutes a Theoretical Contribution? *Academy of Management Review* 14, 490-495.
- [67] Willcocks, L. & Smith, G. (1995). IT-enabled Business Process Reengineering: Organizational and Human Resource Dimensions. *Journal of Strategic Information Systems*. 4(3), 279-301.

## Appendix

Table 1: Implementation Factors from the Four Perspectives clustered or related to Technology, Market, or Organization.

	Venture Capitalists	BPR	Diffusion Theory	System Development
Technological factors	<ul style="list-style-type: none"> <li>• Focus on technology suppliers and partners</li> <li>• Focus on incubating environments for basic ICT-support.</li> </ul>	<ul style="list-style-type: none"> <li>• Focus on information technology in support of business process effectiveness</li> <li>• Recognise the potential of IT</li> <li>• Inductive thinking instead of deductive thinking</li> <li>• Out-of-the-box thinking</li> <li>• Experience with IT</li> <li>• Understanding existing data, applications and databases</li> <li>• IT capability</li> <li>• Information gain instead of technology costs</li> <li>• Collect data from source</li> <li>• Managing IT is culturally dependent</li> </ul>	<ul style="list-style-type: none"> <li>• Complexity</li> <li>• Accurate data</li> <li>• Integration</li> <li>• Interaction</li> <li>• Compatibility</li> <li>• Standards</li> <li>• IS infrastructure</li> <li>• Extensive project definition and planning</li> <li>• IT design</li> </ul>	<ul style="list-style-type: none"> <li>• Efficiency</li> <li>• Maintaining the integrity of throughput</li> <li>• Reliability</li> <li>• Correctness</li> <li>• Integrity</li> <li>• Integration</li> <li>• Usability</li> </ul>
Market factors	<ul style="list-style-type: none"> <li>• Other investors</li> <li>• Market analysis</li> <li>• Sustainable competitive advantage</li> <li>• Exit opportunities</li> <li>• Barriers to entry</li> <li>• Customer experiences</li> <li>• Strategic vision</li> </ul>	<ul style="list-style-type: none"> <li>• Alignment of business processes and strategy</li> <li>• Customer focus</li> <li>• Customer value definition</li> <li>• Definition of customer performance measures</li> </ul>	N.A.	N.A.

<p>Organizational factors</p>	<ul style="list-style-type: none"> <li>• Management</li> <li>• The board</li> <li>• Products and/or services</li> <li>• Revenue model</li> <li>• Organizational structure</li> <li>• True costs of starting and running the business</li> <li>• Growth is obtained organically or by acquisition.</li> <li>• Focus on goals</li> <li>• Leadership</li> <li>• Communication</li> <li>• Incentives</li> </ul>	<ul style="list-style-type: none"> <li>• Top management commitment</li> <li>• Process orientation</li> <li>• Scoping of BPR projects</li> <li>• Clean sheet principle</li> <li>• Holistic redesign of business system</li> <li>• Performance based incentive structure</li> <li>• Skill-base and training</li> <li>• Definition of (non) value adding activities</li> <li>• Performance measurement</li> <li>• Learning</li> <li>• Shared values</li> <li>• Communication</li> <li>• Training</li> <li>• Handling of political controversies</li> </ul>	<ul style="list-style-type: none"> <li>• Job tenure</li> <li>• Education</li> <li>• Resistance to change</li> <li>• Appropriate user-designer interaction and understanding</li> <li>• Commitment to change</li> <li>• Recognition and management of diverse vested interests of IT stakeholders</li> <li>• Social approval</li> <li>• Communicability</li> <li>• Individual learning</li> <li>• Organizational learning</li> <li>• Innovation champion</li> <li>• Specialization</li> <li>• Centralization</li> <li>• Formalization</li> <li>• Top management support</li> <li>• Compatibility with organizational tasks</li> <li>• Relative advantage</li> <li>• Cost</li> <li>• Profitability</li> <li>• Divisibility</li> <li>• Trialability</li> <li>• Observability</li> <li>• Internal need</li> </ul>	<ul style="list-style-type: none"> <li>• Acceptance of change</li> <li>• Training and support</li> <li>• Job redesign</li> <li>• Organizational change</li> <li>• Organizational redesign</li> <li>• Plan implementation process</li> <li>• Human resource development</li> <li>• Understand innovation</li> <li>• Measure effectiveness</li> </ul>
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# The Invisible Borders in Internet Transactions: An Empirical Study of eBay's Auction System

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## Abstract

The popularity of auctions handled through eBay's website demonstrates the marketing power of the Internet. This study examines the influences of price, quality, reputation, and country-of-origin effects on buyers' repeat purchase decisions of jade products listed on eBay. Lower price, although promotes higher volume of bidding, tends to have negative impacts on quality perception. Repeat purchases and reputation differs significantly depending on the country of origin.

## 1. Introduction

One of the most researched Internet transactions in recent years is eBay's reputation system. These studies tend to focus on the sellers' perspective such as how to maximize the final auction prices and what factors lead to sales and premium prices. The results are, however, somewhat conflicting due to the nature of product categories examined in their data sets. Many believe that the seller's reputation, not buyer's, matters in high-priced goods. Studies also find that higher starting bid prices reduce the bid volumes, but lead to a high final sales price; given a successful sale. Others argue that reputable sellers enjoy no boost in price, though their auctions are more likely to be sold; or that the seller's reputation is no longer significant in the case of specific low-priced commodity goods. Additional elements investigated include whether seller is made better or worse off by setting a reserve price. There are also studies that investigate bidding behavior.

## 2. Variables

The purpose of this study is to address issues and information which might be useful to buyer's decision making in Internet transactions. Data are collected from feedback information of sellers who have been listing items under the "jade" category of eBay from the beginning until April 2002. The variables analyzed in this research range from price (not auction price realized, but the starting bid price), relative quality, feedback information, rate of repeated purchase, eBay history, percentage of jade items in the seller's listing,

and origin (country/location) of the seller. In addition to the statistical tests based on quantitative data extracted from eBay, qualitative analysis of item descriptions is performed to understand potential national differences. This is a judgment sample by nature. For instance, sellers who are relatively new, or list under this category occasionally because they happen to have a jade piece or two, are excluded from our sample. As a result, there are 75 valid sample subjects included in this research. Since the researchers of this study have had years of experience with this particular gemstone and have also purchased from most of these sellers in the sample, we have the advantage in evaluating the quality and business practices of these sellers in Internet transactions.

TABLE 1 Variables

Variables	Description
Quality	4-point scale, highest to lowest
Feedback	Number of feedbacks (positive, neutral, and negative)
History	Number of months listed on eBay
COO	Country of origin (US, HK/Singapore, China, and other)
Price	4-point scale, highest to lowest
Repeat Rate	Number of repeat purchase from the same seller
Reputation	Number of net positive or negative feedbacks

## 3. Analysis

The statistical analysis of our data indicates that there is a negative correlation between price and quality. But neither one factor plays a key role in repeated purchase, nor do they have anything to do with the seller's reputation. For this exotic product, lower starting bids also indicate poorer quality. Although low price promotes bid volume and generates more positive feedbacks, it does not enhance the seller's reputation. Generally speaking, sellers experienced with this category tend to offer quality items.

TABLE 2 Influences of Country of Origin

	Rep. Pur	Quality	Price	Reputat.
US	1.81	2.80	2.47	0.9969
HK/S	1.99	2.59	2.88	0.9954
China	2.60	3.25	2.00	0.9867
Other	3.12	2.75	4.00	0.9954

Table 2 indicates a significant relationship among the country-of-origin effect, repeat purchase rate, quality, starting bid price, and reputation. Internet transactions are supposed to be borderless, but invisible borders such as national and cultural differences remain significant. Seller's location matters very much in sources and quality of the items, communication and shipping methods, and consequently buyer satisfaction. Both of the two key variables in this study, reputation and repeat purchase, are significantly influenced by only the seller's location. Another intriguing result is that although US sellers enjoy the highest mean score

in reputation, they generate the lowest repeat purchase rate.

This paper also examines the cultural differences in a seller's item description, including the accuracy of period dating and authentication of so-called "archaic jades". The researchers find US sellers to be the most conservative in this regard. The shipping fees may be high, but shipping methods and auctions terms tend to be described more explicitly. Sellers from China, on the other hand, appear to be quite the opposite. Their descriptions are fuzzy and at times exaggerated. However, their seemingly endless supply of many newly manufactured replicas gives them an unmatched advantage. In a way, these also explain why US sellers score high on reputation, but fail to attract repeat customers.

# Adaptive Inter-Organizational Workflow Management for E-Business Integration

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## Abstract

As the collaboration between companies is facilitated in e-business environment, inter-organizational workflow management becomes an important issue. Because the inter-organizational workflow consists of autonomous organizational workflow, the coordination of these autonomous processes is required. In this paper, a local viewed inter-organizational workflow model is proposed, in which an inter-organizational workflow is defined as a set of block activities. Exception handling rules for internal process are defined with pertinent block activities. Based on the suggested model, a multi-agent system and a coordination algorithm are proposed. For the illustration of the suggested model, an example inter-organizational workflow about book order process is presented.

## 1. Introduction

The workflow management as a technology that automates business process is widely used for organizational process. As the collaboration between companies is facilitated in e-business environment, the integration of organizational workflows becomes an important issue. But there are many obstacles for the integration. Ideally, details of each participating company's workflow should be opened and linked tightly. But each participating company reluctantly opens details of its process and hands over the authority of control to other companies. Moreover, various heterogeneous systems are used in participating companies. So in reality each participating company executes its own work independently and passes the results. This type of collaboration cannot manage the frequent changes or exceptions in the e-business environment appropriately [1].

There are several approaches for dealing with the inter-organizational process. WfMC suggests the standard inter-workflow interface in their reference model in order to link workflows [19]. It supports the exchange of limited control messages including queries and changes [20]. Recent approaches for web service propose the interface standard in order to link services provided in the web [4]. They support the invocation of other company's process and the returning of the results of that service. But they don't consider the characteristics of inter-organizational process. Existing researches cannot be applied directly to the real situations of the inter-organizational process.

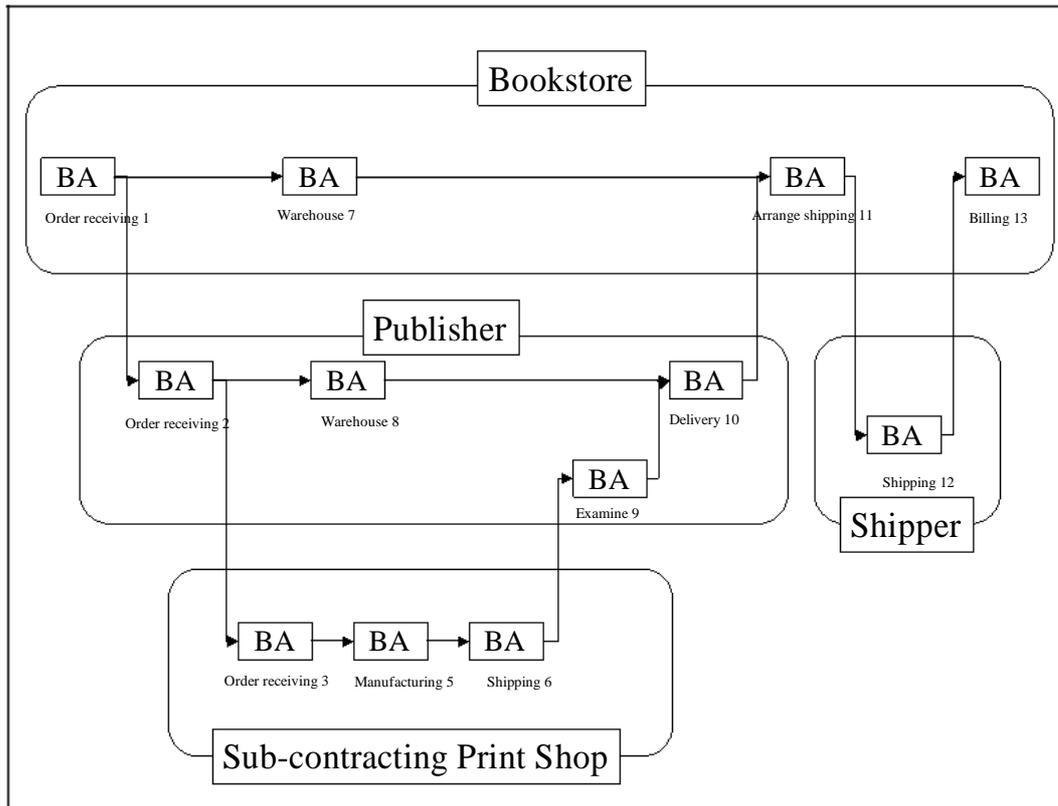
In this paper, the concept of 'block activity' is proposed for modeling autonomous participating workflows. Block activity is the unit of inter-organizational workflow and is the boundary where independent execution is guaranteed. Block activity refers internal activity set of external sub flow. Internal activity set contains applicable exception handling rules. External sub flow contains the information of pertinent company. The criterion of internal and external is depending on who the owner of the workflow is, so proposed inter-organizational workflow model only captures partial view of the whole process in perspective of each company.

To implement the adaptive inter-organizational workflow, multi-agent system is used. This multi-agent system is laying on the existing legacy process management systems and determining the exception handling process. The agent layer communicates with legacy systems using standard XML messages, so the heterogeneity problem can be overcome. To resolve the effects of invoked change or exception on the inter-organizational workflow, software agents coordinate about the requirements for exception handling to attain the common goal. One agent per each company infers the exception handling rules and determines the effecting boundary. Change propagation is invoked when the effect of exception handling is over the boundary of the block activity.

This paper is organized as follows. In section 2, the characteristics of the inter-organizational workflow are described with an example process. Section 3 briefly reviews related works. Section 4 presents the suggested inter-organizational workflow model and its components. Section 5 presents the multi-agent system for adaptive inter-organizational workflow and the coordination mechanism between participating agents. Section 6 presents the detailed description of example inter-organizational process and the usage of the proposed model for some probable exception cases. Finally, section 7 presents a conclusion and further research issues.

## 2. Inter-organizational Workflow

Inter-organizational workflow can be defined as the shared process where several companies are involved in [17]. In this section, an example of inter-organizational workflow is described in some detail. This example will be used later to illustrate our approach. [Figure 1] is a supposed book order process in the e-business environment.



[Figure 1] Inter-organizational process of book order

Consider that a customer places an order for books with Internet bookstore, such as Amazon.com. The bookstore checks the stock of ordered books and in turn places orders for shortage of books with the publishers. At this time, the control of the whole inter-organizational process is handed over to the publisher. The publisher checks its own publishing schedule and updates the publishing schedule. The update of publishing schedule includes placing orders for required raw materials, such as printing paper. After finishing the publisher's internal process, the control is returned to the bookstore. The bookstore determines the shipper and requests delivery. The shipper then coordinates the delivery according to its schedule. Finally, the completion of delivery triggers the last of internal process of bookstore.

This simple example describes the normal process of book order. Of course there is no problem if the process is followed the process just as described above. But there is no means to deal with any situations of unexpected exceptions. For example, the customer may cancel or change his issued order when the order is conveyed to the publisher. The publisher may not be able to print the books as committed or the shipper may not be able to deliver on time. Actually considering cancellation policy of Internet bookstores, they allow cancellation only before the process control is handed over to outer companies, such as publishers or shippers. In the customer's perspective, the cancellation for the perceived single book order process is limited because the process is performed by multiple participating companies.

This limitation wastes customer's time and money and increases customer's dissatisfaction. In the bookstore's perspective, this limitation increases the returning rate and diminishes the profit. So the cancellation option should be possible until the cancellation cost is smaller than the returning cost (including the wasted time value).

The characteristics of inter-organizational workflow are summarized as follows. First of all, the participating companies are autonomous and decentralized. It differs from the established assumption that one main process and other subsidiary processes join the master/slaves relationship. Any company has no right to verify or to control other's processes. Each participating company can control only its own internal process and inter-links outer process via limited messages equally. As seen above example, bookstore cannot directly order publishers or shippers to cancel their internal processes.

Next, participating companies use heterogeneous models and systems for internal process management. This characteristic makes the inter-organizational workflow a very troublesome and difficult issue. The standardization organization, such as WfMC, tries to define a common reference model and interface standards. But this effort is limited because of variety of legacy systems and newly supported services.

For all that, participating companies collaborate with each other for common goal. They are not in a competitive mood, but cooperate for the common goal such as order fulfillment. The inter-organizational workflow should be functioned as a seamlessly integrated

workflow. In order to attain this requirement, the inter-organizational workflow should be adaptive and flexible to the various exceptions and changes that are brought by customers or external environment.

As seen above, the current situation of inter-organizational workflow is just a linking of autonomous workflows for normal execution. The inter-organizational workflow defines the mapping relationship of input/output information and signals between workflow. There is no way to handle abnormal situation. Especially in the e-business environment, exceptions and changes occur frequently and the effect of them is not only on the process of origin but also on the other companies' processes. Even though the current situation is only an intermediate stage, the ultimate goal should be a virtual enterprise that is the seamless integration of e-business.

### 3. Related Researches

Many works for workflow modeling are based on the input-process-output(IPO) approach [13]. It provides the task-oriented view on the workflow, that is, a workflow is considered as a set of interrelated tasks which processes inputs and produces outputs. This approach is good for modeling structured workflow such as business trip approval process and purchasing process. On the other hand, the language/action approach is also used for workflow modeling [12]. It focuses on the conversations between workflow participants, and has merits for modeling unstructured workflow such as project planning. Some researchers employ object-oriented approach for workflow modeling and enactment [10]. Bose presented five classes of objects as key constructs: roles, organization structures, procedures, transitions, and documents. In his model, workflows are executed through message passing between participating objects of the workflow. Both of Chang and Scott and Jennings et al. suggested agent based approach for workflow management. In their architecture, autonomous and problem solving agents interact through their own protocol to achieve the workflow management goals.

The issue of flexible workflow management has been addressed in Casati et al., Reichert and Dadam, Dellen et al., and Bogia and Kaplan [5]. Casati et al. suggested a set of primitives that allow for the modifications of workflow schema, and introduced taxonomy of policies to manage the evolution of running when the corresponding workflow schema is modified. Reichert and Dadam defined a complete and minimal set of change operations that support users to modify the structure of running workflow while maintaining its structural correctness and consistency. Dellen et al. suggested the CoMo-Kit system in which it is possible to refine and extend the software process model during the process execution using the dependency management and the change notification mechanism. In these studies, managing the changes such as adding or deleting tasks

and changing predefined task sequences are the main concern without considering mechanisms to handle changes in the organizational structure and business rules.

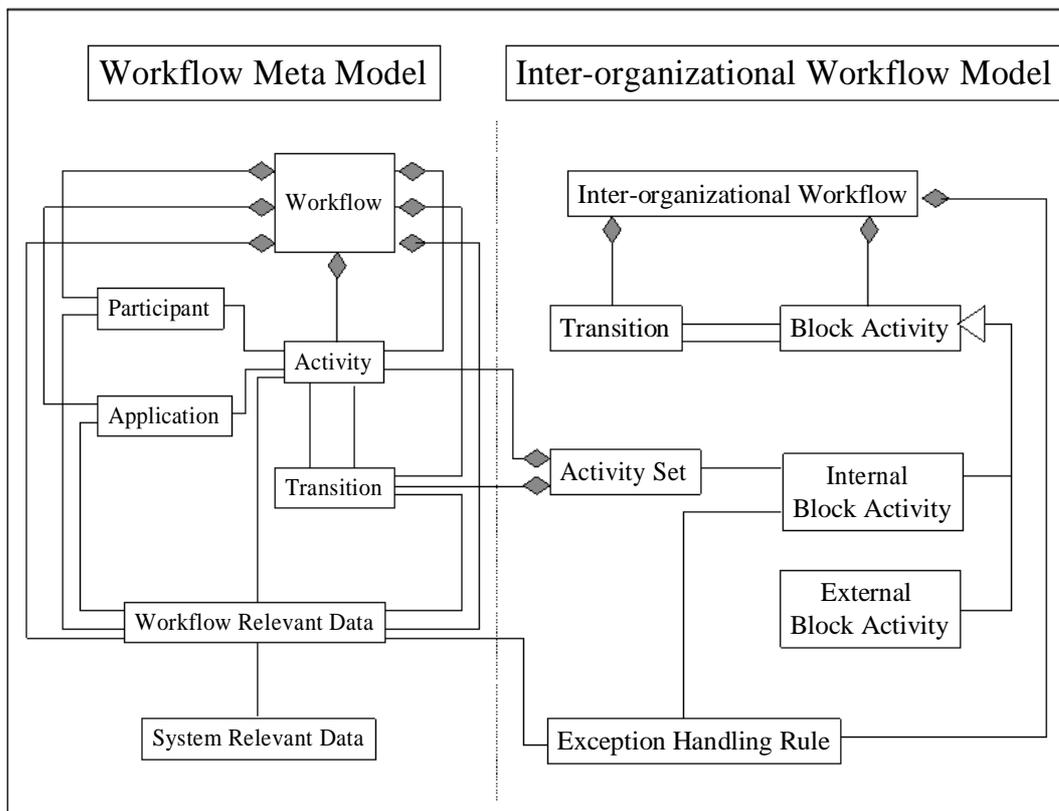
Basu suggested intelligent e-service as the future of workflow in e-business environment [1]. It contains negotiation, complex querying, and exception handling, etc. Aalst, et. al. suggested a public and private workflow for inter-organizational workflow modeling [14]. This formal modeling permits verification of soundness of inter-organizational workflow. But this model requires full information of the inter-organizational workflow before the execution, which is unrealistic in reality. Moreover, this formal model can't reflect the frequent changes or exceptions in e-business environment. Joeris used reactive task agents for flexible inter-organizational workflow [6]. But suggested multi-agent system is not compatible with existing workflow management systems. WfMC suggested the workflow reference model and 5 types of interface [18] [19] [20]. But they defined minimal standards so using only these interfaces for implementing adaptive inter-organizational workflow has limitations.

### 4. Inter-organizational Workflow Model

The proposed inter-organizational workflow model is based on the following two basic assumptions. First, there is no global and perfect view of inter-organizational workflow. Any one of participating companies doesn't have to play the central role of managing the inter-organizational process and doesn't have the right to do so. Each participating company sees the inter-organizational workflow in its own view point. One inter-organizational workflow can be defined differently depending on who defines the inter-organizational workflow. Each company performs its internal process and interacts with other companies for inputs and outputs as defined in the local viewed inter-organizational workflow. The global view is only attained via coordination of local views of participating companies.

Second, the model for inter-organizational workflow not only defines the normal sequence of inter-organizational process, but also manages the rules for handling exceptional situations. As explained in section 2, the inter-organizational process in e-business is exposed to many exceptions and changes and the inflexibility of inter-organizational process is the main obstacle of customer's satisfaction. The change or exception in the inter-organizational workflow effects not only on one participating company's process, but also on several companies' processes. Each participating company has its internal policies for exception handling on its internal process and makes decisions depending on the status of internal process at that moment. The exception handling of full inter-organizational workflow is achieved by coordinating the partial exception handling of participating companies.

The proposed inter-organizational workflow model is summarized as in [Figure 2].



[Figure 2] The inter-organizational workflow model

In this model, an inter-organizational workflow is defined as an ordered sequence of 'block activities' in contrast to that the existing intra-organizational workflow is defined as a ordered sequence of activities. The 'transition' represents the precedence relationship between block activities. The 'resource' captures the information, documents, artifacts, etc, which are exchanged between block activities as inputs or outputs.

#### 4.1 Internal and External Block Activities

The concept of 'block activity' is used as the basic unit for modeling inter-organizational workflow. Block activity is classified into two types by their control authority; internal and external. Because internal and external are relative concepts, inter-organizational workflow model of each participating company is different with one another. This local view of inter-organizational workflow is the appropriate modeling mechanism for autonomous workflows. Participating companies don't have to open their detailed process definitions nor permit access control to their confidential processes. They only abstract their process into a number of block activities and inform the information about them to other participating companies.

The internal block activity refers a separately defined set of internal activities, which have high coherence and share common inputs and outputs. The activities of the referring activity set are already defined in the internal process definition, such as organizational workflow model. The internal block activity is the

boundary of independent and autonomous execution of internal process. The control of inter-organizational workflow is transferred to the pertinent company while its internal block activity is executed. Each internal block activity has inputs and outputs for their execution, which are defined in the resource part of inter-organizational workflow model. Participating companies define and manage exception handling rules for each internal block activity. Exception handling rules are defined

The external block activity refers an external process and is perceived as a black box with pre-defined inputs and outputs. But this black box is not a fixed environmental variable, but a negotiable entity. If the effects of some exception handling rules come over to this type of block activity, the appropriate request for exception handling should be passed to the pertinent company and the result should be checked before the actual exception handling.

#### 4.2 Exception Handling Rules

An exception handling rule is composed of three parts; request type, condition, and result. There are six generic 'request types'; cancel, suspend, resume, roll-back, expedite, and change. The first five is for the process control and the last one is for the information control. Every complicated exception can be interpreted into the combination of these six generic request types. Detailed description for each request type is summarized in the [Table 1].

[Table 1] 6 generic request types for the exception handling

Control	Request type	Description
Process	Cancel	Cancel the currently executing process
	Suspend	Suspend the currently executing process temporarily
	Resume	Resume the currently suspending process
	Roll-back	Roll-back the currently executing process to a certain point
	Expedite	Expedite the currently executing process until a certain time
Information	Change	Change the value of inputs of currently executing process

```

<ExceptionHandlingRule Id="1" name="cancellation for publishing">
  <RequestType>Cancel</RequestType>
  <Conditions>
    <ActivityConditions>
      <ActivityCondition Id="activity23" state="unstarted"/>
    </ActivityConditions>
    <ArtifactConditions>
      <ArtifactCondition Id="publishing schedule" state="generated"/>
    </ArtifactConditions>
  </Conditions>
  <Results>
    <ActivityResults>
      <ActivityResult Id="activity22" state="unstarted"/>
    <ActivityResult Id="activity21" state="unstarted"/>
    <ArtifactResults>
      <ArtifactResult Id="publishing schedule" state="not_exist"/>
    </ArtifactResults>
    <Costs>
      <Cost name="scheduleing cost" value="$4.5"/>
    </Costs>
  </Results>
</ExceptionHandlingRule>

```

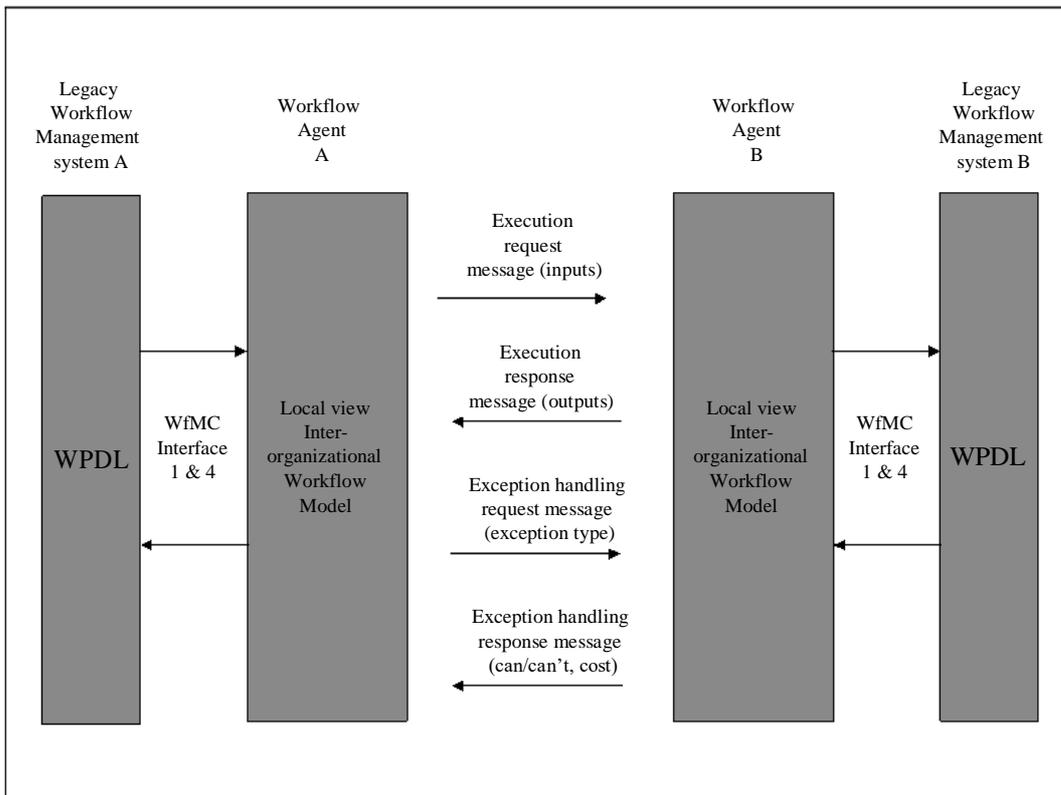
[Figure 3] Example representation of an exception handling rule

The ‘condition’ specifies the required status of inputs, outputs, and activities of referring activity set. The ‘result’ specifies the resulted status of inputs, outputs, and activities. The status for inputs and outputs is defined one of followings; not\_exist, generated, and a specific value. The status for activities is defined one of followings; unstarted, running, suspended, completed, and aborted. And the incurred cost is also specified in the result part. The incurred cost can be used in the negotiation process as the criteria for a decision making about exception handling. [Figure 3] is the example representation of an exception handling rule.

### 5. Multi-agent System for Adaptive Inter-organizational Workflow

In order to be adaptive, the inter-organizational workflow should handle exceptions accordingly, even though the effects of the exceptions go over other

participating companies’ processes. Each participating workflows are autonomous, so the exception handling of inter-organizational workflow is only achieved by the coordination between participating workflows. Software agent has communication and reasoning capabilities for problem solving, so multi-agent system is a suitable mechanism for implementing this coordination. Each software agent represents its belonging company and interacts with legacy process management systems, such as organizational workflow management systems. So this multi-agent system is an additional layer on top of the legacy systems. The multi-agent system for inter-organizational workflow is depicted in [Figure 4]. Each workflow agent defines its own inter-organizational workflow model based on the model defined previous section. It also manages exception handling rules for each internal block activity.



[Figure 4] Multi-agent system for adaptive inter-organizational workflow

Each workflow agent separately defines local viewed inter-organizational workflow model and controls the normal execution of it. When the turn comes round, the workflow agent receives pre-defined inputs for its internal block activity from external block activities and conveys them to the legacy process management system. After finishing the execution of block activity, the workflow agent collects outputs and delivers them to the

appropriate workflow agent of next block activity. The workflow agent also actively monitors exceptional situations and coordinates the exception handling. The workflow agent follows the coordination algorithm for exception handling as described in the [Figure 5]. The more detailed coordination process is presented in section 6 with example case that is explained in the next section.

1. Depending where the exception is occurred
  - A. If the exception is occurred in the internal block activity, detect the exception and decompose it with 6 generic type exception handling request
  - B. If the exception is occurred in the external block activity, receive the exception handling request
2. Query the status of its workflow and update the fact base for reasoning the exception handling rules
3. Choose the currently executing block activity
  - A. If the currently executing block activity is internal, fire the exception handling rules for that request type and adds results into the fact base
  - B. If the currently executing block activity is external, request the exception handling to the workflow agent and wait for the response
  - C. Find the next influenced block activity and repeat stage 3
4. If there is no more influenced block activity or the response is impossible, then response back the requester whether the exception handling can be successful or not

[Figure 5] Coordination algorithm for exception handling

## 6. Example Inter-organizational Workflow

In this section, the Internet bookstore example is revisited. As described in section 2, there are 4 participating companies in this example; bookstore, publisher, shipper, and paper manufacturer.

The bookstore's view for this example inter-organizational workflow is as follows. The customer's order is received and processed. Then orders for some out-of-stock books are issued to the appropriate publishers. While the publishers supply ordered books, the bookstore finds its own warehouse for stocked books. When all ordered books are prepared, books are checked and packaged for shipping. The shipper delivers ordered books to the customer. After shipping, bookstore's billing process is started.

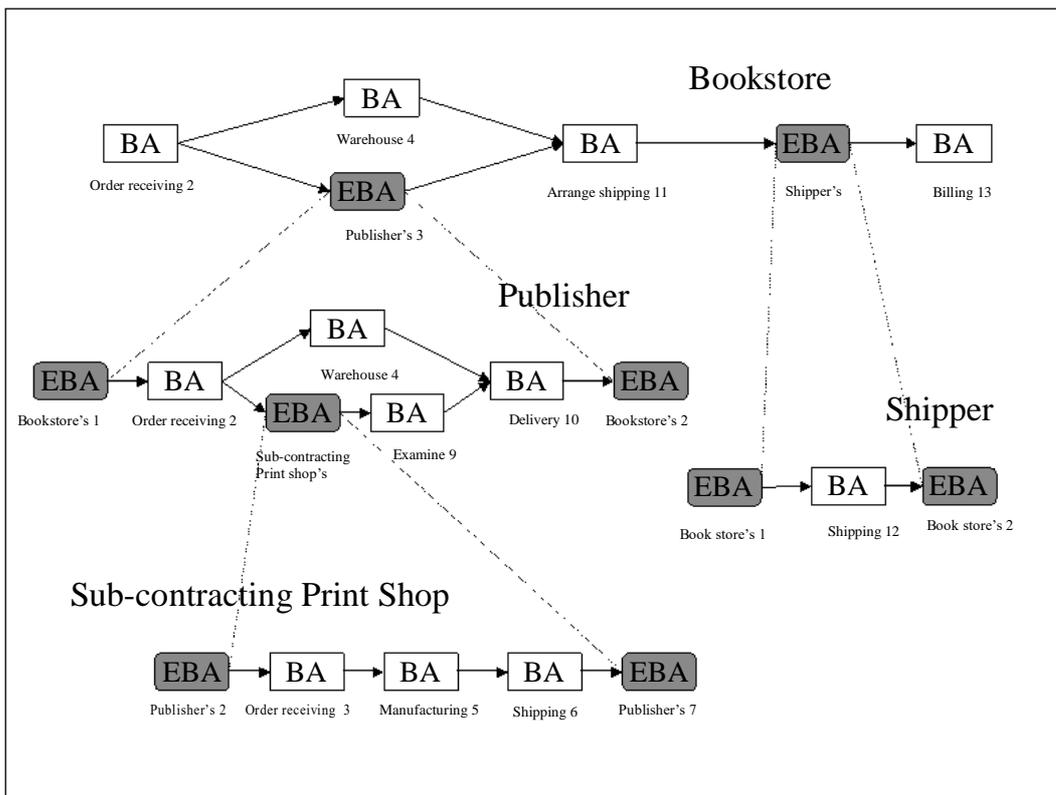
The publisher's view for the same process is fairly different. Publishers don't care who ordered their books or to where their books are delivered finally. They only fulfill the order from the bookstore. The publisher checks its warehouse stocks and re-schedules out-of-stock books. In tern, the subcontracting print shop prints and delivers books as the publisher's schedule. Then the publisher examines the delivered books. Finally, the publisher delivers ordered books to the bookstore and its

role is over in this inter-organizational workflow.

In the shipper's view, the process is simple. The bookstore requests the delivery of some books to the customer. The shipment schedule is made and shipping is accomplished. Then the result is notified to the bookstore.

In the subcontracting print shop's local view, the publisher initiates the inter-organizational workflow. The publisher requests to deliver books to it as their schedule. The print shop follows some internal activities and finally delivers requested books. Then the publisher executes its remaining tasks.

[Figure 6] represents four local views of participating companies. There is no global view, which covers all participating processes. Four companies participate in the same inter-organizational workflow, but each company only sees a certain portion of the full process. Even though the bookstore's view is the widest, it can't see the hidden process of subcontracting print shop. The suggested model reflects this substantial characteristic of inter-organizational workflow. The each local viewed inter-organizational workflow model abstracts the full process using internal and external block activities.



[Figure 6] Modeling of example inter-organizational workflow using block activities

	<p>book store agent</p> <ol style="list-style-type: none"> <li>1A. Detect the cancellation exception from the customer and decompose it as the cancel type exception handling request</li> <li>2. Query the status of bookstore's workflow and update the fact base</li> <li>3B. Current executing block activity, 'publisher's 3' is external, so request the exception handling to the workflow agent of block activity 'publisher's 3' and wait for the response</li> </ol>
	<p>publisher agent</p> <ol style="list-style-type: none"> <li>1B. Receive the cancellation exception</li> <li>2. Query the status of publisher's workflow and update the fact base</li> <li>3A. Current executing block activity, 'print 10' is internal, so fire the exception handling rules for that request type and adds results into the fact base</li> <li>3B. Current executing block activity, 'paper manufacturer's 9' is external, so request the exception handling to the workflow agent of block activity 'paper manufacturer's 3' and wait for the response</li> </ol>
	<p>paper manufacturer agent</p> <ol style="list-style-type: none"> <li>1B. Receive the cancellation exception</li> <li>2. Query the status of paper manufacturer's workflow and update the fact base</li> <li>3A. Current executing block activity, 'order receiving 3' is internal, so fire the exception handling rules for that request type and adds results into the fact base</li> <li>4. There is no more influenced block activity, so response back the publisher agent that the exception handling can be successful</li> </ol>
	<p>publisher agent</p> <ol style="list-style-type: none"> <li>3A. Current executing block activity, 'print 5' is internal, so fire the exception handling rules for that request type and adds results into the fact base</li> <li>4. There is no more influenced block activity, so response back the bookstore agent that the exception handling can be successful.</li> </ol>
	<p>book store agent</p> <ol style="list-style-type: none"> <li>3A. Current executing block activity, 'order receiving 2' is internal, so fire the exception handling rules for that request type and adds results into the fact base</li> <li>4. There is no more influenced block activity, so response back the user that the exception handling can be successful</li> </ol>

[Figure 7] Coordination process between agents of example inter-organizational workflow

The exception handling of inter-organizational workflow is a practical problem especially in the e-business environment. Each participating company can't have the control over other's autonomous process. Each company only has the right to control its own internal process. So in reality, most of Internet bookstores permit users to cancel their orders only before the process is handed over to other company's control.

For example, assume that customer wants to cancel his/her order when the bookstore already handed over the order for the out-of-stocked books. In this case, the control is on the publisher, so the bookstore can't permit customer's cancellation request. The customer has no option, but returning the delivered package after the delivery. This inflexibility raises the customer's inconvenience and lowers the customer's satisfaction. Of course it brings high returning rate to the bookstore.

Using the multi-agent system as described in section 5, this kind of exception handling can be resolved. If each participating company models its internal policy for exception handling, the exception handling process can be checked by coordination between workflow agents. The coordination process of this example case is summarized in [Figure 7]. This posterior verification for

exception handling is different from the prior verification of other formal inter-organizational workflow modeling. The assumption that the information of all participating companies' processes is fully known before the execution is too strict. The decision according to the exception handling rules is dependent on the situations of the company, so the inter-organizational workflow can be more adaptive. This coordination can defer the deadline for cancellation and it must have a good effect on customer satisfaction and returning rate.

## 7. Conclusions

In this paper, a local viewed inter-organizational workflow model was suggested to achieve adaptive inter-organizational workflow. Especially in e-business environment, this model can play the role of intermediate stage. Each participating company has its own autonomous process. The coordination of this autonomous process is important for the inter-organizational workflow to be adaptive. The suggested model uses the concept of block activity. The inter-organizational workflow is abstracted into internal and external block activities. Internal block activity refers an activity set and also contains related exception

handling rules for that activity set. The external block activity refers the owner of that part of process. This modeling is relative and only reflects its local view point. The exception handling rule is defined using 3 slots; exception handling request, conditions, and results. There are six types of exception requests.

A multi-agent system based on the suggested inter-organizational workflow model is suggested and an example case of inter-organizational process is explained. Each workflow agent interacts with legacy workflow management system for querying the current internal status and communicates with each other workflow agents for normal execution and exception handling of inter-organizational workflow. The book order process example illustrates how the autonomous processes can be coordinated in the multi-agent system and how the adaptiveness is achieved.

Further research issues includes revising the suggest model to compatible with existing workflow models including WfMC's reference model. And experiment of the suggested multi-agent system with some commercial workflow management systems is under way.

## References

- [1] Amit Basu and Akhil Kumar, Research Commentary: Workflow Management Issues in e-Business, *Information Systems Research*, Vol. 13, No. 1, pp. 1 – 14, 2002.
- [2] Christoph Bubler and Stefan Jablonski, Implementing Agent Coordination for Workflow Management Systems Using Active Database Systems, pp. 53 – 59, 1994.
- [3] Dickson K.W. Chiu, et. al., Web Interface-Driven Cooperative Exception Handling in ADOME Workflow Management System, *Information Systems*, Vol. 26, No. 2, pp. 93 – 120, 2001.
- [4] Ethan Cerami, *Web Services Essentials*, O'Reilly, 2002.
- [5] Fabio Casati, et. al., Managing Workflow Authorization Constraints through Active Database Technology, *Information Systems Frontiers*, Vol. 3, No. 3, pp. 319 – 338, 2001.
- [6] Gregor Joeris and Otthein Herzog, Managing Evolving Workflow Specifications with Schema Versioning and Migration Rules, TZI Technical Report, 1999.
- [7] Kirsten Lenz and Andreas Oberweis, Modeling Interorganizational Workflow with XML Nets, *Proceedings of the 34<sup>th</sup> HICSS*, 2001.
- [8] Mark Klein and Juan Antonio Rodriguez-Aguilar, Using Role Commitment Violation Analysis to Identify Exceptions in Open Multi-Agent Systems, *Proceedings of the 2001 Conference on Autonomous Agents*, 2001.
- [9] Qiming Chen, et. al., Multi-Agent Cooperation, Dynamic Workflow and XML for E-Commerce Automation, Working Paper of Hewlett Packard, 1999.
- [10] Ranjit Bose, Intelligent Agents Framework for Development Knowledge-based Decision Support System for Collaborative Organizational Processes, *Expert System with Applications*, Vol. 11, No. 3, pp. 247 – 261, 1996.
- [11] Samir Aknine, Using Multi-Agent Systems to Support Workflow Telecommunications Applications, *Proceedings of the 1998 ISIC/CIRA/ISAS Joint Conference*, pp. 537 – 542, 1998.
- [12] T. Winograd and F. Flores, *Understanding Computers and Cognition: A New Foundation for Design*, Ablex, Norwood, 1986.
- [13] Volker Gruhn, Business Process Modeling and Workflow Management, *International Journal of Cooperative Information Systems*, Vol. 4, No. 2 & 3, pp. 145 - 164, 1995.
- [14] W.M.P. van der Aalst and Mathias Weske, The P2P Approach to Interorganizational Workflows, *Proceedings of CaiSE 2001*, pp. 140 – 156, 2001.
- [15] W.M.P. van der Aalst, Exterminating the Dynamic Change Bug: A Concrete Approach to Support Workflow Change, *Information Systems Frontiers*, Vol. 3, No. 3, pp. 297 – 317, 2001.
- [16] W.M.P. van der Aalst, Loosely Coupled Interorganizational Workflows: Modeling and Analyzing Workflows Crossing Organizational Boundaries, *Information and Management*, Vol. 37, pp. 67 – 75, 2000.
- [17] W.M.P. van der Aalst, Process-Oriented Architectures for Electronic Commerce and Interorganizational Workflow, *Information Systems*, Vol. 24, No. 8, pp. 639 – 671, 1999.
- [18] WfMC, Process Definition Interchange – Process Model (WfMC-TC-1016-P), Version 1.1, 1999.
- [19] WfMC, The Workflow Reference Model (TC00-1003), 1995.
- [20] WfMC, Workflow Standard – Interoperability Abstract Specification (WfMC-TC-1012), Version 2.0b, 1999.

# “Nothing Changes Overnight”: The Diffusion and Acceptance of E-Business Experiences with New Ways of Working and Communication Processes

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## Abstract

This paper deals with new work concepts, especially the so-called alternating telework. A close relationship between the introduction of E-Business and telework is assumed. This type of working can be interpreted as a technology push factor. A research project at the University of Trier (Trier Telework Study) investigated living and working conditions of 277 alternating teleworkers. The findings focus on the following research topics: reasons for participating in telework, working-time arrangements and flexibility, organization of family obligations, ways of balancing work and leisure. Moreover, integration of telework into a traditional office environment (e.g. flow of information, tasks performed) is analyzed too. This includes reflections on the current e-transformation processes. The analysis consider first results of an ongoing research project as well as evidences from further (empirical) studies in the field of E-Business. Consequences, requirements and conditions for implementing electronically supported work arrangements are discussed. It seems important to combine the new situation with the traditional settings and processes in an effective and social way. Furthermore the findings suggest a management of integration.

## 1. E-Business and telework: Definitions, types of telework and penetration

The increasing availability of modern information and communication technologies enables organizations to change their styles of operation, procedures of communication and the ways of cooperation. In this context E-Business concepts are becoming more and more incident. The term is still vague and covers several dimensions (e.g. dot-com companies, e-commerce). Within the scope of our research studies “E-Business” is defined as the sum of all processes in a firm that are supported by information technologies leading to a close integration of business, communication and transaction processes on a company and market level (see figure 1) [15] [11]. According to this frame of reference the organization and coordination of internal business processes is an important module. This includes different forms of electronically based work concepts (e.g. computer supported cooperative work, virtual teams),

particularly several kinds of telework. In this context a close relationship between the introduction of E-Business and telework can be seen. For example, introducing this type of working is a suitable test for virtual structures.

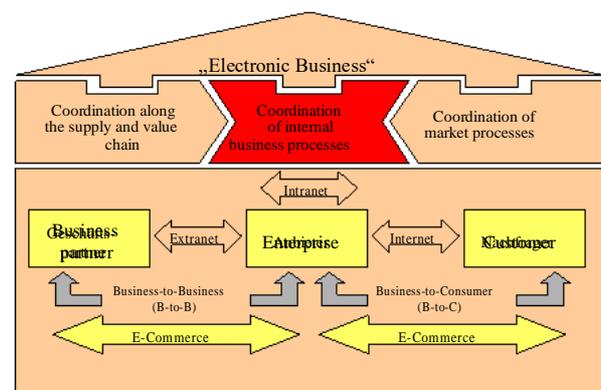


Figure 1 Dimensions of E-Business

Moreover telework can be interpreted as a technology push factor. Attained experiences offer valuable clues to current changes in companies (e.g. leadership, business reorganization). Nevertheless, within the recent years a growing number of people chose their home as a workplace while using modern communication networks to transfer work results. These work arrangements imply partly a shift of gainful employment into the domestic sphere. This ongoing process in working life as well implies that “The Joy of Flex” [3] is no longer a theoretical idea, it’s rather an expectation that is proved more often in practice. According to results of a pan-European survey conducted between March and May 2002 13% of the EU workforce are practicing currently some form of telework [5]. In 1999 this share accounted for 6%. In contrast, about 25% of the U.S. labor force practice some form of telework in 2002. This suggests a considerably lack between the U.S. and the EU. But there are marked differences among the European countries as figure 2 illustrates. A north-south decline can be noticed. Scandinavian countries show leading positions in terms of highest telework diffusion rates. The Netherlands are still an exception. Here, political and public support programs as well as a great openness towards technological and organizational innovations among the population may have positive influence on the spread of

telework. In addition, a sufficient technological infrastructure can be assumed in the leading areas. For example, in 1999 the Swedish government initiated regional growth agreements supporting the network ability within 15 areas (e.g. local/urban area networks) [9].

Telework solutions generally need a technological infrastructure (e.g. internet). This includes as well the use of modern communication technologies like e-mail, corporate databases and/or videoconferencing [7]. The introduction of telework takes (remote) access for granted. In regard to the acceptance of E-Business the use of modern technologies plays an important role too.

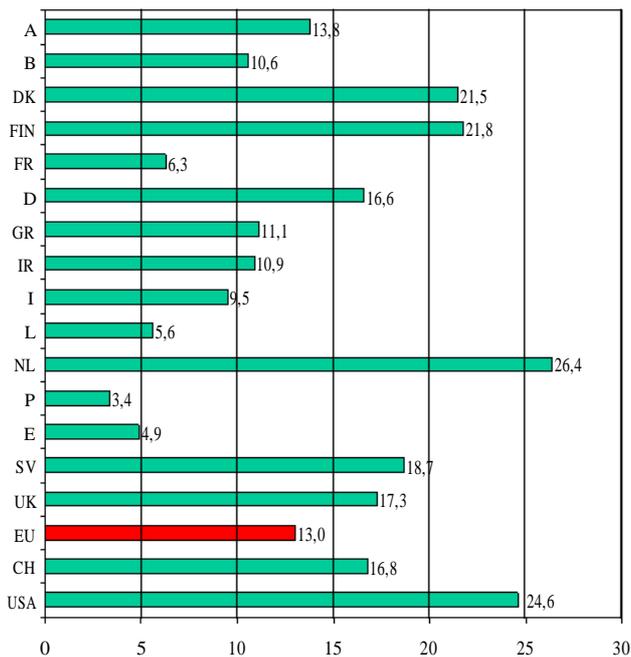


Figure 2 Spread of telework in the EU and the U.S. (in % of labor force 2002)

However, about 17% of the workforce in Germany (=6 million employees) are currently referred to as teleworkers. Figure 3 illustrates the 1999 and 2002 German diffusion rates according to different forms of organization. The results show a fast growing segment of supplementary home-based telework. Majority of occasionally teleworkers is male. However, this mode of working implies a mobilization of ideas off the job as well as employees' need for time flexibility. Obviously, the availability of modern technologies did not replace the traditional office workplace, but more and more employees want to benefit from spending a fraction of the working time at home. In other words: the organization of work in modern societies is still based on a clear distinction between residential and working area.

Alternating telework suggests blurring lines between living and working sphere, additionally organizational and personal challenges (e.g. leadership, culture, time-management) might be limiting factors for this form of work. This can be a reason for less acceptance of models with relative high amount of working days at home.

Currently only about two percent (1,6%) of the German workforce spends at least one full working day per week at home. Since 1999 the number of these teleworkers has not grown much at all (+0,1%). In contrast about 58% of German labor force is interested in alternating telework. With regard to the introduction or extension of telework there are obviously various barriers. Some of them will be discussed in this paper. Nevertheless, home-based working is normally perceived as an unusual change as Maitland (with reference to a report in UK magazine Flexible Working) states: “[...] they began to feel their work identity was being challenged. Some went into the office when not required. Some found it difficult to cope with the blurring of boundaries between work and home. One felt it necessary to recreate his office at home, complete with flip-chart stand, photographs of his colleagues, and a name badge on his study door” [13].

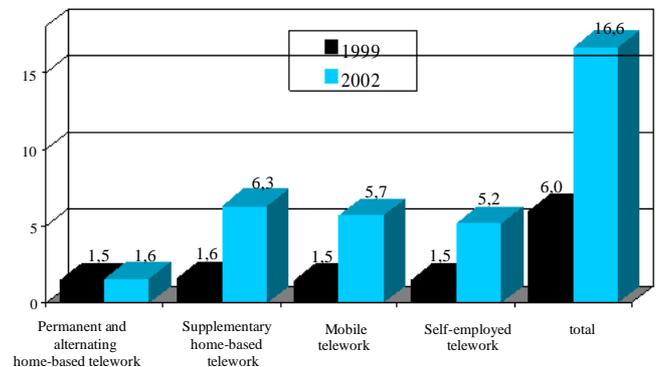


Figure 3 Types of telework and penetration in % of German labor force (1999 and 2002)

## 2. Experiences with E-Business and alternating telework

Our outline of research results considers different variables determining the acceptance of E-Business. Figure 4 presents several dimensions that are discussed below.

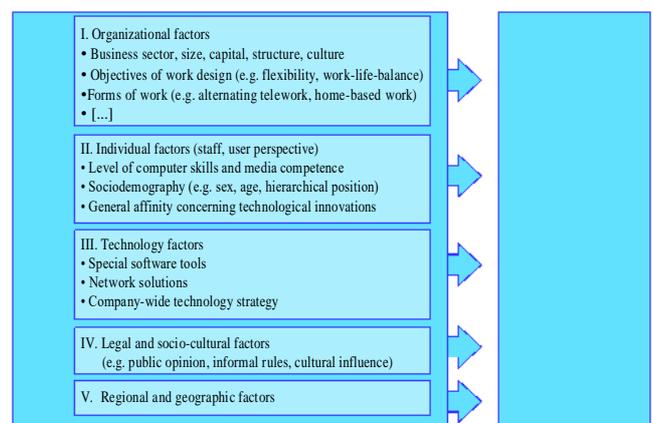


Figure 4 Frame of research

Hence our research concentrates on employees who stay about two full working days a week at home. Furthermore

these teleworkers are in salaried employment (only one employer) and use an online connection to company wide computer networks. Our definition excludes self-employed workers, occasional business travelers as well as mobile field staff (mobile telework). Details on participants of the Trier Telework Study are presented in table 1.

Table 1 Demographic composition (Trier Telework Study)

- sample size: n=277
- sex: women 68 %, men 32 %
- family status: 82 % married
- children: 76 % have at least 1 child at home
- age: 38 years (average)
- level of education: 37 % apprenticeship, 30 % university degree, 21% college of higher education, 9 % technician, 3 % other
- 48% official in charge, 32% expert, 14% staff function, 6% business management
- days per week at home: 3,1 (average)
- hours of work: 48 % full-time workers (approximately 20 hours per week at home), 52 % part-time workers (approximately 15 hours per week at home)
- telework experience: approximately 1 year
- job tenure: approximately 12 years

### 2.1 Setting up a project: Employers' objectives in E-Business and employees' motives for telework

Within the framework of an ongoing research study (so-called SPIRIT-project) we are currently investigating the E-Business introduction processes in 6 German and 3 U.S. American companies. The studies will likely be finished in the year 2004 [4]. First results indicate that market orientated objectives seem to be the most important reasons for implementing projects (e.g. speed-up business processes, customers demand, lower costs, competitiveness). Companies make use of internal project teams or special task forces. In this context "high-level"-champions (e.g. chief executive officers, management board) play an important role. They are responsible for developing a corporate E-Business strategy and the coordination of various projects. This might be a success factor while assigning priorities needs authority. Furthermore employees, business management, ICT-and/or special business units are involved in the implementation process. Interestingly enough customers and suppliers seem to play more and more the role of driving forces. In our study we can observe an integration of "outsiders" in several activities within E-Business projects (e.g. participation in project teams). Networking often is still at the beginning but external forces can exert pressure on internal changes. Speeding-up rather seems to be a mega trend in companies as well as in modern

societies. Changes in market are an important push factor for internal reorganization processes. Electronically based co-operations between companies, customers and suppliers become more and more reality. In this regard it is quite unsurprising that procurement, customer relationship management and supply chain management applications are of top priority in many companies. The adoption of online procurement still varies significantly with establishments' size (e.g. in number of employees) or the turnover [8]. According to results of a study in four European countries and the U.S. (n=2321 companies) conducted in 2001 about the half of German establishments practiced online ordering of goods or similar business transactions (e.g. maintenance, repair and organization goods). Especially small companies (e.g. < 9 employees) have less experiences than bigger ones (e.g. 200-499 employees) (for further details see table 2).

Table 2 Online procurement according to companies' size in 1999 and 2001 (in % of respondents)

		Employees									
		< 9		10-49		50-199		200-499		> 500	
Year	State	'99	'01	'99	'01	'99	'01	'99	'01	'99	'01
	D	14,0	34,6	16,8	48,5	34,4	50,8	37,1	64,0	38,0	55,2
	Fin	26,6	24,9	38,6	52,1	64,4	40,1	55,2	48,4	50,8	58,0
	UK	23,0	26,7	27,5	30,7	38,4	41,6	42,0	47,8	42,6	28,2
	I	6,4	22,5	14,6	19,9	21,9	27,3	22,2	33,7	47,0	34,0
	U.S.	29,3	34,9	22,8	44,0	19,4	47,6	45,6	61,1	41,9	64,7

Results of this study suggest as well a varying intensity of online procurement. In the U.S. 58% of those companies who practice e-procurement at least ordered about 5% of the goods online. In Germany 43% reached this share. More generally, lacks of diffusion and use of modern technologies (e.g. internet, intranet, extranet) occur in the professional context. These phenomena are already known in terms of various "digital divides" (e.g. less well-educated, older people) [12]. In the context of E-Business unused or refused media opportunities might closely be related to these groups. There seem to be further, specific obstacles [1]: doubts of profitability, insufficient customization, lacking applicability of products, deficient usability and/or less acceptance by employees. Often supposed benefits are still not attained (see chapter 3 for further obstacles to corporate E-Business).

However, market as well as customer demands are in the focus of E-Business efforts. This can be proved by the results of a recently conducted study: in 2001 about 81%

of German CIO's (=Chief Information Officer, n=310) pursue the speeding-up of business processes as the most important target of E-Business projects [2]. Besides 63% reported to increase their flexibility (e.g. adaption to market changes). Figure 5 illustrates most important E-Business targets of German companies in 2001. Financial budgets will likely not be reduced in 2002. Quite the contrary might be done: majority of the interviewed companies (56%) stated to expand their investments. This is remarkable while about 30%-50% are current not satisfied with the results of ongoing projects. However, 68% attempt to increase their attraction for employees while restructuring their business processes.

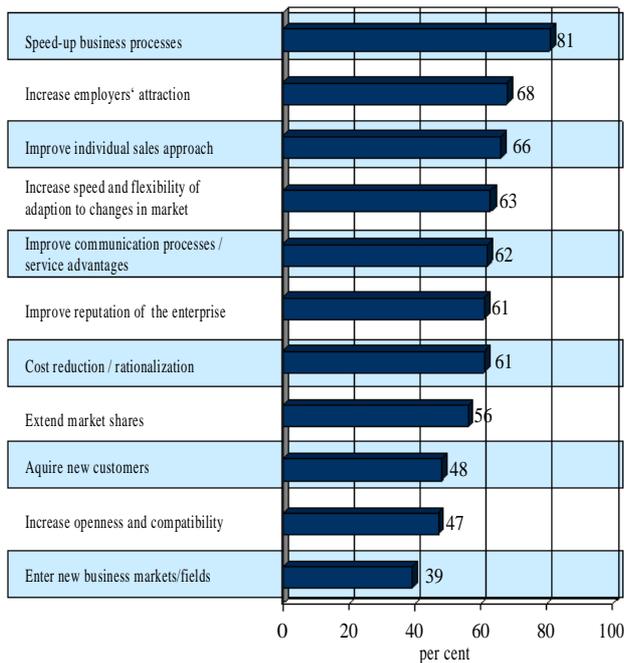


Figure 5 Most important E-Business targets 2001 (in % of respondents, n=310 German Chief Information Officers)

Humanizing the workplace is a factor of increasing importance. Telework can be one step in this direction. Thus company programs are not only introduced on the basis of strategically expectations alone. The Trier Telework Study suggests a wide range of motives. Setting up a telework pilot is often initiated by employees themselves. Demand for telework can trigger a “bottom-up”-process. Figure 6 illustrates motives for engaging in alternating telework for men and women. Decisions can differ significantly between men and women (e.g. parental leave, offer from employer). Considerations may be affected by individual preferences, private circumstances (e.g. children) and/or work-related aspects (e.g. career, coordination). For example, majority of female teleworkers (76%) use telework for balancing private and working life and are between 30 and 39 years old. In these cases parental leave is the main reason for working at home.

Correspondingly, employment switches to part-time. Here, the participation in alternating telework may be characterized as a “career break with time limit” (e.g. taking care of (preschool) children).

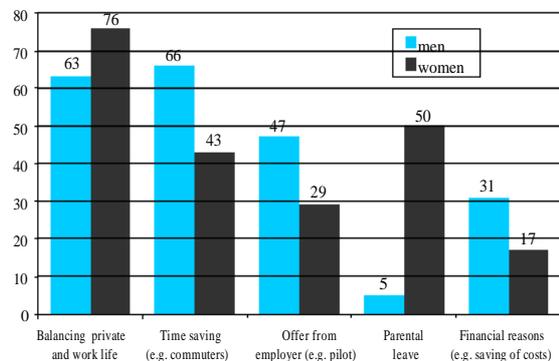


Figure 6 Reasons for telework in % of respondents (Trier Telework Study)

Legal regulations in Germany (until January 2001) did not allow to work more than 19 hours per week during parental leave. However, telework has the quality of a bridge to the labor market. After a certain period of time female employees might give up working at home and return to office-based work. This probably can be a factor for relative low diffusion rates of alternating telework in Germany and the EU in the last three years.

Nevertheless, majority of male workers (66%) chooses alternating telework to avoid commuting. This factor has been an origin in discussion of telework. Nilles together with co-editors Carlson, Gray and Hanneman [14] already examined in 1976 human as well as economic costs and benefits of reduced traveling while using communication links with the employer. Consequently, the dominating term in the U.S. has been “telecommuting”. To avoid commuting problems is still an important reason.

However, our male teleworkers are usually full-time employees and only switch the work location for about two days per week. Executive staff (e.g. employees in managerial position) work usually about 15 hours at home. In contrast, officials in charge stay the longest time outside the office (average: 3 days; 19 hours) (see figure 7). In some of these cases jobs and/or operations are made suitable for home-based working (e.g. less complex work routine). Particularly, younger men and/or male executives could anticipate disadvantages in getting ahead. Working largely outside the office might be perceived as an “out of sight, out of promotion”-situation. Just 30% of male teleworkers is between 30 and 39 years old. Here, professional career is at its beginning. That’s why average age of male workers might be higher than of female teleworkers (men: 43 years vs. women: 36 years). Furthermore demands of work (e.g. tasks performed, consultations) certainly affect time arrangements.

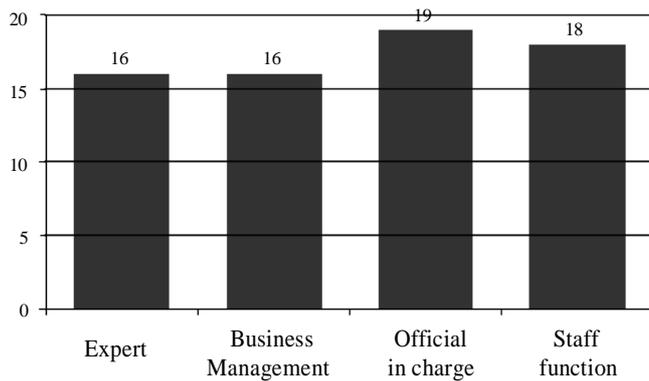


Figure 7 Average hours of work time at home (Trier Telework Study)

For example, it is more difficult to coordinate work with colleagues if tasks entail a high level of communication and a high extent of spontaneous conversation (e.g. involvement in networks). However, private-familiar circumstances (e.g. children, age, attitude to telework) and supposed benefits for work life balance are important factors concerning time-arrangements.

## 2.2 Temporal flexibility, coordination and communication

The benefit of temporal flexibility cannot be granted. Self-organization and self-discipline favor a good work arrangement. Regulations and social factors (e.g. company demands, acceptance) may constrain temporal flexibility. For example, about 25% of the teleworkers have to work core hours at home, nearly 32% are obliged to regard contractual obligations and nearly 41% have to follow defined deadlines (“milestones”). Moreover teleworkers coordinate their activities with office staff and must be attainable at certain times. The necessity and the amount of coordination are influenced by several factors (e.g. position, job characteristics, full-/part-time, organizational skills). However, domestic life has its own rules and rhythms. Non-work and work has to be organized, teleworkers have to integrate different “time schedules” (e.g. kindergarten hours, business hours of spouse, family obligations, child care). The organization of working time varies with the availability of human resources. Especially in cases where children are present this often means working at unusual times (e.g. in the evening, at the weekend). For example, some female respondents work when their partners can look after the children, otherwise the assistance of a (paid) day mother is necessary. Therefore temporal flexibility is a matter of frames and situations. Additionally the telework experience is an important factor. There are significant differences in the working time arrangements between beginners and experienced teleworkers (for further details see figure 8).

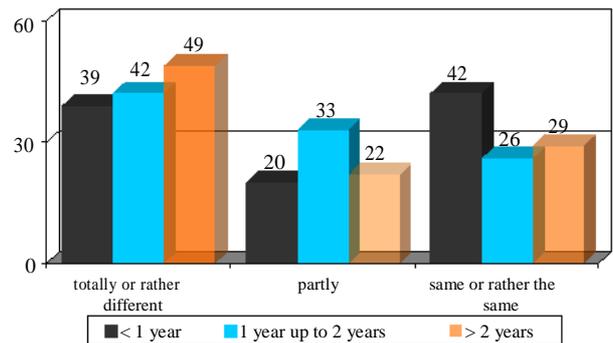


Figure 8 Organization of working time at home (Trier Telework Study)

About the half (49%) of those who already work more than two years from home organize their working time totally or rather different. In contrast the majority (42%) of the beginners (<1 year telework experience) practice traditional labor rhythms. In other words: Teleworkers can profit from learning processes in the way how work is organized. Nonetheless, the majority of our participants report a growing potential of flexibility (e.g. shopping, authority matters). Especially, those who can organize home-based working time totally or rather different (compared to hours of work in the office) seem to gain from the new circumstances (see figure 9).

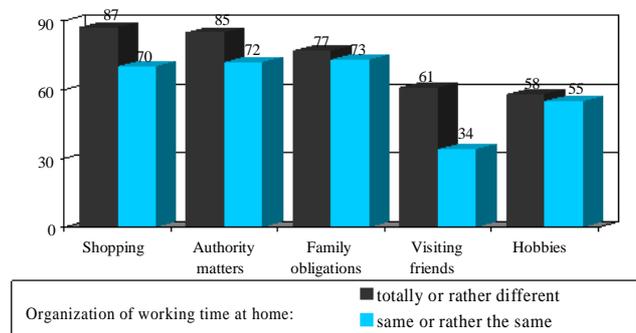


Figure 9 Flexibility of obligations and leisure time (in % of respondents) (Trier Telework Study)

In this context perception of traditional time and leisure arrangements have an impact on how work is organized. Many leisure activities are conducted in groups (e.g. sport club) and still take place in the evening or on the weekend. To work unsocial hours implies an exclusion from social events. In addition, societal landmarks and industrial organisation of labor are constraints of equal importance.

Modern technologies play a key role in the context of new forms of working. Therefore one might state: “To speak of organization is to speak of communication”. There are marked changes in communication patterns while working at home (see figure 10). Electronically supported communication (e.g. telephone) increases significantly, face-to-face meetings, especially informal

conversation with colleagues, decrease. E-Mail use is taken for granted: about 77% of teleworkers report a more frequent use in case of staying at home. In contrast typical opportunities (e.g. lunch, coffee break) occur less because of reduced presence at office. For example, majority of teleworkers (60%) perceive a decrease of informal conversation. Consequently, working outside the central office requires one's own initiative to be informed.

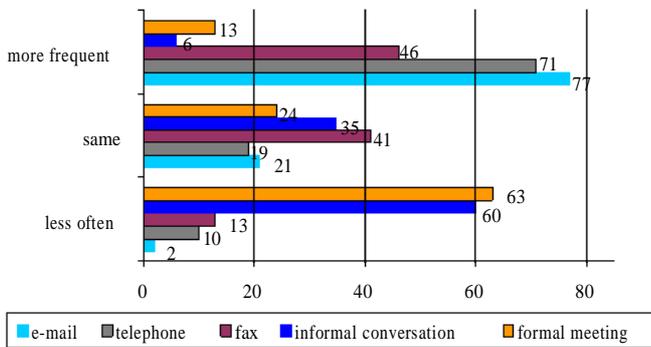


Figure 10 Media use and communication (in % of respondents) (Trier Telework Study)

It is important to keep efficient communication links. Furthermore a lack of media competence or “computer skills” leads to unexpected frustrations.

### 3. Organizational change: Perspectives for E-Business and alternating telework

Alternating telework is still an unusual mode of work. This applies to management, family as well as employees. Furthermore, know-how and new competencies (e.g. computer literacy, time-management, self-discipline) are critical factors (for further details see figure 11). Generally spoken: the acquisition of skills might be an important “bottleneck” within the scope of current organizational changes. New requirements for skills are arising continuously in the course of technological progress. Current problems (e.g. technology refuses (“refuseniks”), skills gap, diffusion lack) may intensify in the future. Therefore staff and management developments as well as further trainings are particularly suitable. To avoid mismatches between offered and demanded qualifications private-public partnerships should be improved (e.g. schools and industry).

Difficulties in managing teleworkers, insufficient knowledge of management and problems in organizing communication are still dominant barriers to the introduction of telework. Management may as well has to learn new skills. Leadership implies electronically based relationship. This includes adaptations of methods for controlling or ensuring a good flow of information. Reduced visibility in case of remote-work environments requires trust. In this context personal relationships as well as technological solutions are applied. For example, in 1999 data security problems ranked top as a

constraining factor for telework. This has been a predominant barrier to telework for about 53% of German decision makers [6]. To ensure IT-security, data security and to raise confidence among users is an important condition in the course of E-Business (e.g. commercial transactions, payments systems) too. Nonetheless, extension of telework is driven by acceptance of the social and work environment (e.g. managerial attitude, employee attitude, family).



Figure 11 Competencies and skills

The implementation of telework arrangements pushes the integration of technologies of interaction (see figure 12).

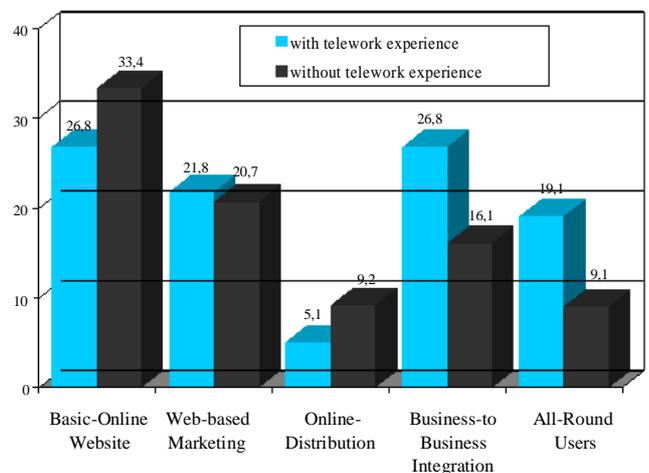


Figure 12 Telework experience and E-Business

For example, 26% of companies with telework experience have integrated Business-to-Business applications. The share for establishments without telework experience is accounted for 16%. This implies experiences with non-territorial offices (e.g. desk-sharing), flexi-time schedules or changes on corporate culture too. However, the speed of organizational transformation is accelerating with the influence of different groups (e.g. management, works council, employees, customers, suppliers) (see figure 13). The

power of driving or restraining forces pushes or slow down the changes. Time can take up the role of a success factor.

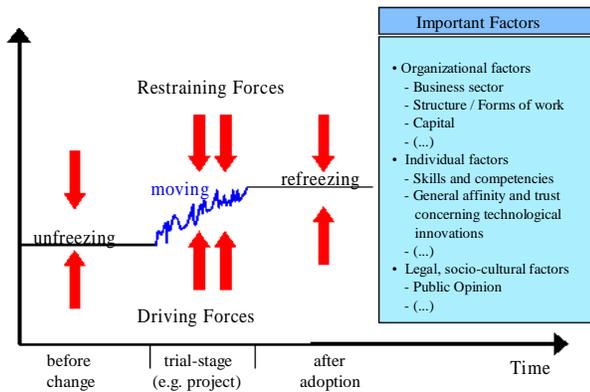


Figure 13 Organizational change

For example, 47% of German CIO mentioned long periods of amortization (e.g. quantitative improvement) as a main barrier to implementation of E-Business [2]. Previous experiences indicate that the majority of companies (about 80%) is still at the beginning in the process of transformation [2]. Germany will probably not pass through an “electronic revolution”. What is more likely to happen is an “evolutionary change” of traditional working practices: “Nothing changes overnight”.

## References

[1] Bundesministerium für Wirtschaft und Technologie, Monitoring Information Economics, Factual Report and Trend Report, München, 2002.  
 [2] Cap Gemini Ernst and Young & Competence Center Electronic Business, e-Transformation-Studie. Hindernisse in der Umsetzung der e-Business-Ambitionen in Deutschland,

Berlin, 2002.

[3] Capowski, G., “The Joy of Flex”, Management Review, 1996, March, 12-18.  
 [4] Competence Center Electronic Business, SPIRIT: Project description, [http://www.ceb-trier.de/spirit], October 15, 2002.  
 [5] Gareis, C., The Intensity of Telework in 2002 in the EU, Switzerland and the USA, Unpublished Paper, Bonn, 2002.  
 [6] Empirica, Conditions for the development of new ways of working and electronic commerce in Germany, ECATT National Report Germany, Bonn, 1999.  
 [7] Empirica, Verbreitung der Telearbeit in 2002. Internationaler Vergleich und Entwicklungstendenzen, Unpublished Paper, Bonn, 2002.  
 [8] Empirica, Stand und Entwicklungsperspektiven des elektronischen Geschäftsverkehrs in Deutschland, Europa und den USA unter besonderer Berücksichtigung der Nutzung in KMU in 1999 und 2001, Abschlussbericht für das Bundesministerium für Wirtschaft und Technologie, Unpublished Paper, Bonn, 2001.  
 [9] Jäckel, M., Rövekamp, C. & Dostal, W., Zukunftskonzeption “Telearbeit in Rheinland-Pfalz”, Mainz, 2001.  
 [10] Jäckel, M. & Rövekamp, C., Alternierende Telearbeit. Akzeptanz und Perspektiven einer neuen Form der Arbeitsorganisation, Wiesbaden, 2001.  
 [11] Jäckel, M. & Rövekamp, C., Alternierende Telearbeit. Implementierung - Evaluation – Handlungsempfehlungen, in: Weiber, Rolf (Ed.): Handbuch Electronic Business, Wiesbaden, 2002 (forthcoming).  
 [12] Jäckel, M., Inclusion, exclusion and the diversity of interests. Is 'digital divide' an adequate perspective? Paper presentation, IAMCR & ICA Symposium on "Digital Divide", Austin, Texas, November 15-17, 2001.  
 [13] Maitland, A., Telework doesn't quite work yet, Financial Times Online, [http://www.ft.com], May 16, 2000.  
 [14] Nilles et al., The Telecommunications-Transportations Trade-Off, New York, 1976.  
 [15] Weiber, R., Electronic Business, in: Möhrle, M. & Specht, D. (Ed.): Lexikon Technologiemanagement, Wiesbaden, 2002 (forthcoming).

# Foundation for a Successful Web Site

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## Abstract

There are many factors that come into play when designing the architecture for a successful web site. The web site must be up and running 99.99% of the time. Redundancy is the key to achieve this.

## 1. Introduction

There are many ways to design the architecture of a web site. The two options are to either host the site using an outside vendor, or purchase the necessary hardware and software to host and maintain the site yourself. A 4-tier architecture is by far the best method of design for hosting your own site. The goal of a 4-tier architecture is to manage each specific function separately while still working together. The client would be the 1<sup>st</sup> tier. The application servers would be the 2<sup>nd</sup> tier. The payment servers would be the 3<sup>rd</sup> tier, followed by the database as the 4<sup>th</sup> tier.

## 2. Hardware

There are a number of key hardware and software that make up the 4-tier architecture. Some of the hardware discussed will include the routers, load balancers, and servers along with a description of the software and providers that operate each of these machines.

### 2.1 Routers

Routers are used to direct traffic to the appropriate machines. By definition they are computers that determine the best way to direct data packets to their specified destination.[1] The dominant supplier of routers today is Cisco Systems (CSCO). Another vendor is Nortel Networks (NT). Price for routers in the market today range from \$10,000 to \$55,000. Cisco routers range slightly higher than it's competitors but they attract a list of loyal consumers who pay the extra time and time again.[2]

### 2.2 Firewall

Firewalls are a key component in guarding the traffic flow in and out of your site. Their key purpose is to prevent unauthorized access into the site. In other words they are a defense mechanism between the network inside the firewall and the network outside of the firewall. They

also track the users accessing the site and keep a record of what they do and where they originate from and report any problems to the system administrator.[3] Cisco Systems, Check Point (CHKP), and NetScreen are some providers of firewalls in the market today. Prices for firewalls range from \$11,000 to \$18,000 with Check Point and Cisco dominating the market.

### 2.3 Load Balancer

Load balancers are either hardware, for large websites, or software that are used to direct traffic to servers that can respond and return the content to the user quickly.[4] By balancing the workload of the servers, the overall performance of the website is improved. Cisco Systems, F5 Networks (FFIV), and Nortel Networks are some major providers of load balancers. The price ranges of load balancers are from \$4,500 to \$30,000 and F5 Networks leads the market with new features.

### 2.4 Web Server

Web servers are dedicated computers that contain information, clients can access. They contain all the files needed to make up the webpage. The software required to operate the web server is usually free of charge bundled with the purchase of an application server. The most common vendors are Apache, Microsoft (MSFT), and Sun Microsystems (SUNW).[2]

### 2.5 Application Server

The application server runs on its own hardware and acts as the brains behind the application. It is a machine that services requests of other hardware and software on the network to satisfy a client's request. Some common vendors are BEA Systems (BEA), Borland (BORL), and IBM (IBM) with price ranges from \$8,000 to \$35,000 per CPU.[2]

### 2.6 Payment Server

The payment server processes all the credit card payment transactions that a user submits. In most cases it is best to outsource payment transactions to outside vendors. An example of a payment processing company is iAuthorizer and Authorize.Net. This company for example provides order forms, shopping carts, CGI scripts,

and transaction processing. They use a protocol called SET (Secure Electronic Transaction), which provides security for credit card payments.[1]

### 2.7 Database Server

A database server can be used to store text, graphics, sound, personal information about customers, and track inventory as well as various other tasks. Their key purpose is to store structured information, become self-describing, support transactions, and permit rapid information retrieval. Key players in database management are IBM, Microsoft, and Oracle with price ranges from \$11,000 to \$40,000 per CPU. [2][5]

### 3. Design Layout

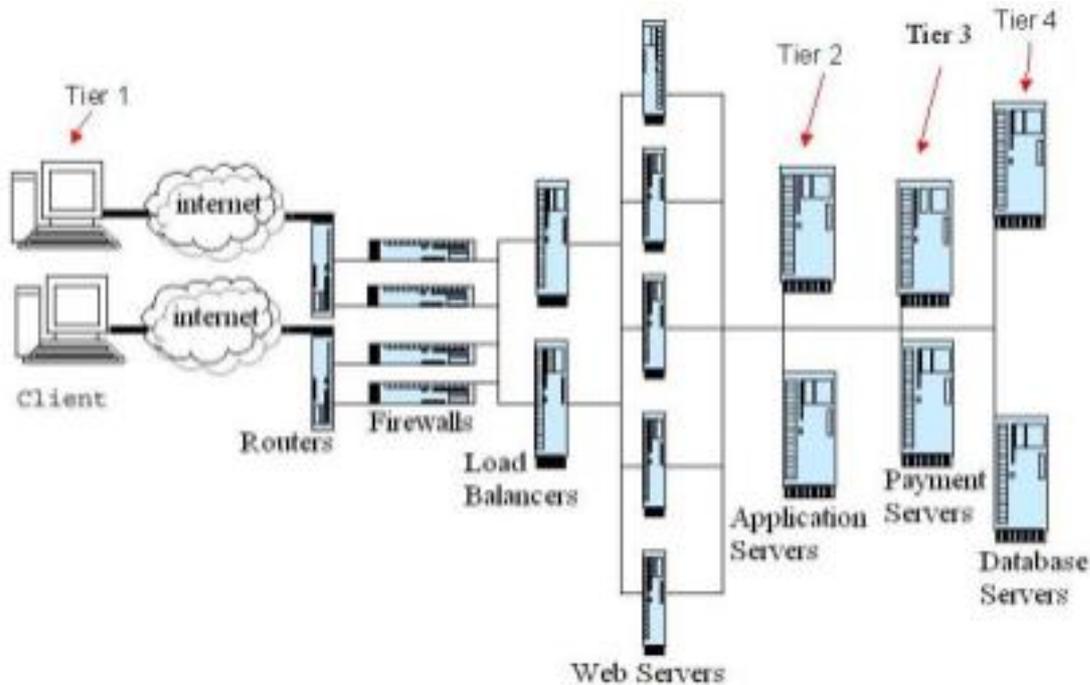
The important part of all this is how everything is connected together. As I mentioned before redundancy is the key to the success of the website. In some cases it might be justified to spend the extra money and have backup machines in the case that one fails to operate correctly. If at any time a router, firewall, or server fails to operate correctly, the entire site and business will shut down until that machine is fixed. If there is a backup then business will continue operating while the first machine becomes operational.

Using two Internet connections from different ISP's will also enhance the flow of traffic into the site. Again if one network line goes down, clients can continue to access the site through the second connection.[6]

The combinations of these hardware, software, and layout will produce a foundation for a successful web site. This architecture design combined with a good business plan and the right resources becomes the start of the next successful business.

### References

- [1] Gary P. Schneider, James T. Perry. "Electronic Commerce, 2<sup>nd</sup> annual edition". Course Technology, 2001.
- [2] Business 2.0 Staff. "The Who's Who of E-Business". January 2002 Issue. [www.business2.com](http://www.business2.com)
- [3] Elias Awad. "Electronic Commerce from Vision to Fulfillment". Prentice Hall 2002.
- [4] 3Com. "Section 3 Firewalls, Webchaches, Load Balancers, and Print Servers". [http://www.3com.com/other/pdfs/products/en\\_US/61000215\\_sec03.pdf](http://www.3com.com/other/pdfs/products/en_US/61000215_sec03.pdf)
- [5] G. Winfield Treese. Lawrence C. Stewart. "Designing Systems for Internet Commerce". Addison Wesley 1998.
- [6] 4 Tier Architecture



# Missions for Executives in Developing an E-Management Platform

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## Abstract

Under the impact of internet, many promises of e-management are provided. However, so far, executives are still skeptical in developing e-management platform, the anxieties come from the fact that too many IT developing projects failed. In practice, IT is a specialty which is quite heterogeneous to business management, to achieve e-management makes the issue of integration of these two domains can not be neglected any more.

A failed project is by no means the duty of IT team only; it would be the reason that the interaction between IT team and executives is too weak. To reduce the gaps in platform developing, executives have some missions are offered, they are: a. Let IT group understand executives' business affairs; b. Review architecture of platform; c. Involve to system test. It deserves to assert that, in developing an e-management platform, executives are not just the users, but also a part of developing members.

## 1. Introduction

Under the impact of internet, prefixing "e-" to nouns has become a token of this era, for example, e-business, e-commerce, e-learning, e-management ... and what you like. However, rigorously surveying, "e-something" is not just a slogan, it still indicates that two different specialties – IT and the field after "e-" should be integrated seamlessly. For example, e-management implies that executives can make decisions in aid of a platform which is built by IT, however, whether this platform can be satisfied by executives is always skeptical, since IT is a specialty which is quite heterogeneous to business management. In other words, promises of this platform would not be fulfilled thoroughly once there are some gaps between these two specialties. Unfortunately, too many failed projects reveal that gaps are almost inevitable. This anxiety just likes a black cloud on internet sky, how to diminish or even ruin such gaps is the incentive of this paper.

No doubt, many executives are skeptical. They've heard outsized promises, and they've spent a lot of time and money on information system developing, but the gain is poor [1]. It would be believed that the critical causes of failure of system come from software architecture. Though, software and hardware are two main components in an information system, however, the

problems of hardware are much fewer in comparison with software. In software developing, one of important keys to success is team work [2]. The members of the team are not just software developers, but also executives. A successful project developing, both program developers and executives should communicate and cooperate with each other seamlessly.

In this paper, e-management is the subject to be studied. The causes why gaps between IT and management existed will be discussed, and then solutions to avoid such gaps happened are tried to offer.

## 2. Causes of Failure

A project of an e-management platform developing, in essence, is a project of software systems developing, therefore, the reasons why software products failed in marketing are more or less accommodated to this research. It is well known that software developers' and executives' disdain for rigid procedures lead to failure, in most of projects, instead of conflicts happened, executives always choose to keep away from software team in period of system developing, and make themselves just as users of the e-management platform.

During developing an e-management platform, usually, the time executives involved compared to the one whole system built is very short. Project always commences in necessities collected, in most cases, executives list all necessities to IT team, then they never involved the developing process until system finished. After the system on line, instead of being praised, IT group always receives endless criticisms. Under such weak interaction between IT team and executives, it is difficult to make these two parts cooperate coincidentally.

It is unfair for IT group to bear the burden of proof; a failed information system is by no means the duty of IT team only. To make project success, the causes of failure should be tried to remove. To sum up, the solution to enhance the interaction between IT group and executives should be revealed. If executives could be more aggressive to involve the project developing, the gaps between IT and executives would be reduced significantly. Therefore, in order to make e-management platform being developed successfully, missions for executives should be specified clearly, and this is the main purpose of this paper.

### 3. Missions For Executives

Usually, IT developers are apt to communicate with machines well. In order to improve the relation to engineers, it would better for executives to be active to discuss with IT team. In other words, there are some missions for executives in developing e-management, they are offered as follows:

a. Let IT group understand executives' business affairs: It is not enough for IT team to construct the platform for executives if only a function list is given. It is necessary for executives to hold a meeting for IT group before project is begun, let IT group know how business run day by day, and what kind of data is important in making decision. Such communication can not be neglected absolutely, or the direction of project will deviate from executives' visions unconsciously.

b. Review architecture of e-management platform: Before programming, architecture of platform should be designed completely, the elements should be reviewed by executives are: user interfaces, data flow and functions. However, almost executives have no IT background, the architecture should be presented by a visual model which can be communicated without any impediment, UML (Unified Modeling Language)[3] would be a very convenient tool in presenting software architecture. Executives have not to hesitate to challenge the architecture, it is very critical, a right architecture is half the success of a project.

c. Involve to system test: System test is a routine step before functions finished, but bias will be inevitable if this step only done by IT group, once something insufficient or inexact found too late, unexpected cost will happen possibly. Executives involve to test system, not only bias

can be reduced, but also schedule of project can be checked.

The gaps between IT team and executives would be diminished, if above obligations could be carried out.

### 4. Conclusions

Most of time, there are no any overlap between IT group and executives in business, but the impact of e-management creates breakthroughs in these two domains. To develop an e-management platform successfully, the interaction and communication between executives and IT group should be very frequent. To improve the interaction between IT and executives, three missions for executives are offered as: a. Let IT group understand executives' business affairs; b. Review architecture of e-management platform; c. Involve to system test. To specify the missions for executives is to assert that executives are also a part of developing members; they are not just the users of system only.

### References

- [1] John Hagel III & John Seely Brown. "Your Next IT Strategy" *Harvard Business Review*, 2001, Oct, 105.
- [2] Detlev J. Hoch, Cyriac R. Roeding, Gert Purkert, Sandro K. Lindner. *Secrets of Software Success: Management Insights from 100 Software Firms Around the World*, Harvard Business School Pr. 2000.
- [3] J. Conallen, *Building Web Applications with UML*, Addison Wesley, 2000.

# Global Geo-Demographic Data and GIS for E-Business

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## Abstract

The results of a comprehensive survey of the availability and characteristics of digital geo-demographic data in 40 countries around the world are presented.

Geographic information systems (GIS) often used in conjunction with the Internet are being used by technologically savvy companies to perform marketing studies and provide location specific data such as maps to clients and customers. However, the national level Availability and characteristics of the required digital geo-spatial data vary considerably from nation to nation. Every country's data differs in terms of existence, cost, accuracy, precision, format, content, and availability over the Internet. Some countries (such as Switzerland and the United Kingdom) have current data on every hectare and house along with demographics for every group of 100 residents available for interactive web-based mapping and analysis. Other nations have such data in only non-digital forms and then only internally. Most nations are intermediate in terms of the use of characteristics and availability of geospatial data relevant for E-business.

Presented here are the results, especially those pertaining to E-business, of an e-mail survey of the national census and national mapping authorities of 40 selected countries. These the G7, Russia, China (PRC, Taiwan and Hong Kong), India, Australia, many European countries, along with 4 other Asian, 4 Latin American, 2 Middle Eastern and 2 African nations. Also presented is statistical analysis of the responses and information from follow-up questions.

## 1. Background

A survey of the National Census authorities and National Cartographic Authorities of 40 developed and developing countries was conducted starting in January 2002. The purpose of the survey was to gauge the character and availability of geodemographic data and infrastructure data (principally streets and building locations and footprints) in a GIS format for use in marketing, location studies and similar applications. The surveys consisted of 23 and 24 questions respectively questions initially emailed to the national census authority and national mapping, cartographic cadastral or land planning authority of the country the authorities were

identified using a web page maintained by the U.S. Census Bureau and a web page maintained by the U.S. Geological Survey and containing contact information for 120 census bureaus and mapping authorities. Follow-up by email, fax and in several cases phone call elicited further information. As of Mid June 2002, 19 of the 40 countries had responded, to one or the other survey instrument or replied to the email with the results presented and analyzed below.

## 2. Choice of Countries

The criteria for selection of the countries were primarily the likelihood based on prior knowledge or development level that GIS. Thus the USA, Canada, Australia, Great New Zealand, Britain, the Netherlands, Sweden, Finland, Switzerland, Singapore were selected. Also economic importance in the global economy was a factor thus Japan, France, Italy, Spain, Germany, India, Russia, China were selected although the level of technological development was significant for most of these countries as well. In an attempt to get a good geographic distribution of countries, Israel (middle east), South Africa (Africa) Chile, Argentina, Brazil, and Mexico (Latin America), Eastern Europe (Czech Republic, Poland, Hungary) Asia (Taiwan, South Korea) were selected. Australia and New Zealand also helped to represent every populated continent. Review of web sites led to the inclusion of Malaysia and Egypt to the list. In addition Belgium, Luxembourg, Denmark, Austria, Ireland and Portugal. The decision to only survey 40 countries was arbitrary and exclusion of such countries as Greece is probably more of an oversight than a deliberated decision. Exclusion of Sierra Leone (last on the U.N. Development Index) and a host of "fourth world" countries reflects the low likelihood that these nations use GIS in their census or mapping activities.

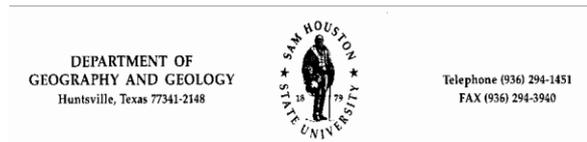
## 3. Contacting the Respondents

Most census bureaus had web sites which were visited. Most national mapping authorities likewise had web sites. Using either contact information on the web or information obtained via enquiries to the sites web master emails were sent to representatives of each authority. As of June 2002, 19 of the forty census authorities had responded. Also responses from 12 Mapping authorities were obtained. Follow up faxes were sent to the

authorities. This elicited several additional responses. In addition to those countries that responded by completing and returning the survey three countries responded but did not complete the survey. The Czech Republic stated they would respond but did not, the French stated (in French) they would only respond to a survey in French and the Mexicans indicated in Spanish that they had information on a web site about their use of GIS. Singapore responded to the email by stating they do not use GIS in their census activities and to the fax by faxing back a polite refusal to respond to the questionnaire. The countries that responded before June 2002 included. Australia, Belgium, Brazil, Canada, Finland, Hong Kong, Iceland, Israel, Italy, Germany, New Zealand, Norway, Singapore, South Africa, Sweden, Switzerland, Taiwan, the USA and the United Kingdom. Japan, Denmark, Holland and Portugal were all contacted indirectly and their use of GIS was determined, but no official response was made prior to mid-June 2002. Thus 19 countries responded completely, three additional countries responded by stating they would reply soon, but did not follow through nor respond to faxed enquiries. Thus an initial 50 % response rate was achieved. A Spanish, French and Chinese language version of the survey was prepared but no responses to these versions of the survey dispatch in May of 2002 were received prior to the preparation of this paper.

The surveys of mapping authorities involved more difficulties than the survey of Census authorities. This is largely because although all developed nations use GIS for national mapping, the mapping function resides in many agencies with many names in different countries. Thus in England one has an Ordnance Survey in the U.S. one has a Geologic Survey with a cartographic division, in Canada mapping is in the department of natural resources, in Norway a national Cartverk (Cartographic Workshop), in Switzerland a National Cadastral agency, in Holland a spatial planning agency, in Portugal a National GIS, in Spain an Institute for Geography, in Japan a national geographic Survey, etc, etc. In Chile and Italy mapping is a function of the military but in Chile it is an institute of military geography while in Italy the navy maps the coastal areas, the army the interior and the air force aerial navigation charts are a responsibility. Therefore just identifying which agency has responsibility. In fact they can be overlapping responsibilities. Thus the topographic maps in Germany are prepared by one agency at the national level while the cadastral maps are state by state as is aerial photography and land-use mapping. Since in all the agencies GIS is widely used figuring out exactly who to have responded has been a problem. Nevertheless as of mid-June 2002, 12 agencies have responded.

A sample of the cover letter is presented in figure I below.



*Dear National Census Authority representative...the following are instructions for completion and return of the accompanying survey of GIS use in your organization.*

**INSTRUCTIONS:**

This is a survey of GIS use in Census Authorities around the world. Agencies in your country and in 39 other advanced countries are being contacted. The following page contains a survey of geographic information system (GIS) use in developing products such as maps used by your agency. It is being used to gather information that potential customers and other users of your agencies data would appreciate having. The results of this survey will be presented at the world's foremost international GIS conference. They will not be used for commercial purposes. Please answer every question to the best of your ability. Place a check mark in the appropriate box for the (YES X, NO\_\_\_) format questions. If you are unsure about the nature of the question or need clarification about what is an appropriate response, do not hesitate to contact me. Your personal information name phone number etc. will not be divulged and are request solely so I can contact you to clarify any questions I have about your response to this survey. Please respond within one month of receiving this instrument. I will make an effort to follow up with the recipient of each and every survey instrument sent out within two weeks of the time this survey is dispatched.

- ◆Can you provide examples of Businesses, consulting firms or research institutes in your country using GIS? If so please send that information to Dr. Leipnik at the address below.
  - ◆Can you provide a sample of the GIS products your agency generates? If you can provide samples of such data please send them via airmail or email to Dr. Leipnik at the address below.
  - ◆Can you provide publications or references to publications describing your available cartographic products (maps and/or GIS data)? If so please send the title of such publications and information on how it can be obtained to me at the address below.
- You have my special thanks for participating in this survey, which will help users of GIS around the world!

Sincerely

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Sam Houston State University  
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Phone (936) 294-3698  
Fax (936) 294-3940  
Email: [geo\\_mrl@shsu.edu](mailto:geo_mrl@shsu.edu)  
(that is geo underscore mrl)

#### 4. Questions on the Census Survey

The questions on the survey include queries intended to obtain contact information (items 1 and 2). A question about how often the national census is conducted (item # 3) which is designed to gauge the currency of data. A question about the smallest geographic units data is collected for (#4) which is designed to gauge the spatial precession of data. A question about privacy restrictions (#5) designed to determine to what extent individual responses are masked by aggregation. A question (#6) about use of postal addressing systems to track respondents which gives insights into integration of census enumeration with postal addressing something useful to marketers who have address lists of customers. A question (#7) about collection of income data and at what level of geographic subdivision this data is collected. This question provides perhaps the most important demographic information to marketers besides the actual presence of respondents. A question (#8) about occupational employment and at what geographic subdivision this data is collected which is useful to marketers and is not asked by all censuses of population. A question (#9) about educational attainment. This is a key determinant of future income and development and thus of great interest to marketers. A question (#10) about residential living arrangements and at what level this data is collected and aggregated. This is a key determinant of wealth and demand for a wide range of consumer products. A question (#11) about business location and activity this is an item frequently missing from census of population but is of great interest to companies doing location studies since it helps identify competitor's locations. A question (#12) about the level of interest expressed in obtaining census data for use in geodemographic studies. This question gauges the level of use of this data in geodemographic marketing and location studies. If little use is being made of the data a low number on a scale of 1 to 10 would be reported. A question (#13) about whether the agency uses GIS, this is a key question since if GIS is not used then by the agency then GIS data sets for the country will require a major effort by outside parties to develop. If the answer to this question is no then the respondents skip to number 23, a question (#14) about the number of years the agency has used GIS. A question (#15) on how useful on a scale of 1-10 GOS has been for the agency. A question (#16) about what features are portrayed on the base maps used in the GIS. This is designed to determine if building footprints are present, if only enumeration district boundaries are present, if roads are present etc. This is key to many other uses of the data. Question (#17) concerns the public availability of GIS data related to census activities. Since GIS may be used in an organization but the data may not be publicly available. Question (#18) concerns how long data has been publicly available. Question (#19) concerns what language the data is available in. Question #20 concerns the cost of the data. The question specified cost for nationwide coverage but most agencies specified cost for a smaller area. Question

#21 concerned available over the internet and the URL of the website where the data resided. Question #22 concerned use of GPS technology by the agency. This was to see if the base maps are being built by this approach. Question #23 concerned plans for future use of GIS at the agency as was relevant for those not yet using the technology.

*A sample of the survey instrument is reproduced in figure II below.*

#### Survey of GIS use and availability of national demographic data for inclusion in a GIS.

1) Country Name: \_\_\_\_\_

Date: \_\_\_\_\_

2) Official Title of Agency: \_\_\_\_\_

\_\_\_\_\_

Mailing Address

\_\_\_\_\_

Name and Title of person completing survey:

\_\_\_\_\_

Email: \_\_\_\_\_

Phone: \_\_\_\_\_

Fax: \_\_\_\_\_

3) At what time interval is a national census of population conducted? \_\_\_\_\_.

4) What is the smallest geographic subdivision for which data is collected? \_\_\_\_\_.

5) What privacy restrictions exist? \_\_\_\_\_.

6) Is census information collected using a postal addressing system to track respondents locations? **YES** \_\_\_ **NO** \_\_\_.

7) Is income data available for individuals in your country? **YES** \_\_\_ **NO** \_\_\_. At what level of geographic subdivision is the data available? \_\_\_\_\_.

8) Is employment data available? **YES** \_\_\_ **NO** \_\_\_. At what level of geographic subdivision is the data available? \_\_\_\_\_.

9) Is educational attainment data available? **YES** \_\_\_ **NO** \_\_\_. At what level of geographic subdivision is the data available? \_\_\_\_\_.

10) Is residential living information data available? **YES** \_\_\_ **NO** \_\_\_. At what level of geographic subdivision is the data available? \_\_\_\_\_.

11) Is business location and characteristics data available? **YES** \_\_\_ **NO** \_\_\_. At what level of geographic subdivision is the data available? \_\_\_\_\_.

12) On a **scale of 1-10** where **1** represents “**no interest**”, **5** represents “**moderate interest**”, and **10** represents “**very active interest**”, how much interest has been expressed by businesses in your country for using and obtaining geo-demographic data? \_\_\_\_\_.

- 13) Does your agency use GIS?  
**YES** \_\_\_ **NO** \_\_\_. (If **NO**... go to # 23).
- 14) For how many years has your agency employed GIS in the census process? \_\_\_\_\_ **Years**.
- 15) On a scale of 1-10; where 1 represents “counter-productive”, 5 represents “moderately useful” and 10 represents “extremely useful”. How useful has GIS been in the process of enumerating and characterizing the population of your country?  
 \_\_\_\_\_.
- 16) What features (streets, building locations, etc) are present on the base-map you also use to portray census results on? \_\_\_\_\_.
- 17) Is the census data publicly available in a GIS?  
**YES** \_\_\_ **NO** \_\_\_. (If **NO**... go to # 22).
- 18) For how many years has census data in a GIS format been public ally available? \_\_\_\_\_.
- 19) What language(s) are the data available in?  
 \_\_\_\_\_.
- 20) What is the cost (in local currency) of nationwide GIS format census data? \_\_\_\_\_.
- 21) Is the data available over the Internet?  
**YES** \_\_\_ **NO** \_\_\_, **URL**: \_\_\_\_\_.
- 22) Does your agency use global positioning systems for systematic mapping?  
**YES** \_\_\_ **NO** \_\_\_.  
 23) Does your agency plan to use GIS in the future?  
**YES** \_\_\_ **NO** \_\_\_. At what date? \_\_\_\_\_.

Thank you for your assistance... You may return this survey via fax to (01) 936-294-3940, via email to [geo\\_mrl@shsu.edu](mailto:geo_mrl@shsu.edu) that is geo “underscore” mrl @ shsu.edu or by mail to Dr. Mark Leipnik, Department of Geography SHSU, P.O. Box 2148, Huntsville, Texas 77341.

## 5. Questions on the Survey of Mapping Authorities

The initial three questions on each survey were contact information related questions and were the same as on the census survey. Question #4 related to the scale of topographic maps and was designed to determine the precision of available data for inclusion in a GIS. #5 concerned the features portrayed. If buildings are portrayed this is significant for business applications. Question #6 regarded the intervals that maps are prepared. In the U.S. for example remapping in non-systematic with the average age of topographic maps being 28 years and the oldest map that is still the official “current” topographic being 67 years old. Question #7 dealt with the system of geographic subdivision in use. Question #8 regarded tracking residences, it is important since to geo-code customer information one needs this data or street address ranges. Question #9 concerns if business locations are mapped. Question #10 regards a postal addressing system. Question #11 asks if GIS is used.

Question #12 asks for how many years has it been in use. Question #13 asked how useful the system is internally. Question # 14 regards tracking street addresses. Without such street address ranges or building footprints geo-coding customer locations can only be done to a region. Question #15 regards the public availability of GIS data. Question number #16 formats the GIS data is available in. Question # 17 involves the cost of the national level data. Question #18 regards the languages the data is available in. Question #19 involves availability of data on the Internet. Question #20 involves level of interest expressed by external users in obtaining data on a scale of 1-10. Question number 21 involves use of remotely sensed imagery, question #22 involves use of digital aerial photography. Question #22 involves availability of this digital aerial photography data. Question # 24 involves future likelihood of using GIS.

## 6. Follow-up Questions

For all agencies responding to the survey a follow up message was sent in every case where GIS was used it enquired as to what GIS software was being employed. Also various clarifications were sought. For example if the agency such as New Zealand indicated that the smallest geographic subdivision that data was available for was a “meshblock” but did not define what this constituted a request to clarify what this was made. Also those agencies not responding to the initial email were emailed again within two weeks, and then a fax was sent to all non-responding countries. Another approach was then adopted for non-respondents with emails sent to GIS specialists in academic institutions in each country. Thus Japan, Denmark, Holland, Austria and Portugal were contacted. The Universities were University of Tokyo, Copenhagen University, University of Utrecht, Technical University of Vienna and New University of Lisbon. This produced some useful information. Specifically that GIS was not in use by the Dutch who had their last census in 1971 and use registers and for Japan were GIS is in use in the national census but at the very beginning stages and application.

With respect to choice of software ESRI products were used by all respondents with the exception of the Australian census authority which uses Map/Info products primarily.

## 7. Response Rate

The response rate and the time it took to respond were a very useful if indirect measure of the efficiency of the organizations and their responsiveness at least to queries made in English. The most rapid response was from Norway which Responded within 1 day. Singapore and Sweden also responded within 2 days and Germany responded within 1 week. Many countries failed to

respond within 1 month and a follow up email was sent, after two months a follow up fax was dispatched. The table below shows the response status as of mid June 2002. As an objective measure of the development level of the country the UN development program human development index rank is also displayed. The table lists responders in order of response.

**Table 1.**

Norway	Yes 4/16	Yes	2	1	1
New Zealand	Yes 4/16	Yes	2	1	19
Sweden	Yes 4/17	Yes	3	2	4
Australia	Yes 4/22	Yes	8	3	2
Germany	Yes 4/25	No	11	4	17
Switzerland	Yes 4/30	Yes	15	5	11
U.K.	Yes 1/5	Yes	16	6	14
Spain	Yes 5/8	Yes	19	7	21
South Africa	Yes 5/15	Yes	31	8	94
Hong Kong	Yes 5/19	Yes	35	9	24
Israel	Yes 5/20	Yes	36	10	22
Taiwan	Yes 5/21	Yes	37	11	Not rated
USA	Yes 5/22	Yes	38	12	6
Italy	Yes 5/27	Yes	43	13	20
Belgium	Yes 5/27	Yes	43	13	5
Finland	Yes 5/28	Yes	44	14	10
Brazil	Yes 5/30	Yes	46	15	69
Singapore	Yes 5/30	No	46	15	26
Iceland	Yes 5/31	No	47	16	7
Canada	Yes 6/5	Yes	52	17	3
France	4/30	?			13
	French				
Czech Rep.	receipt 5/2	?			33
Mexico	5/10	Yes			51
	Spanish				
Netherlands	Academic	No			8
	Response				
Japan	Academic	Yes			9
	Response				
Luxembourg	No	?			12
Denmark	Academic	yes			15
Austria	No	?			16
Korea	No	No			27
Portugal	Academic	Yes			28
	Res				
Argentina	No	?			34
Hungary	No	?			36
Poland	No	?			38
Chile	No	?			39
Russian	No	?			55
Federation					
Malaysia	No	?			56

China	No	?	87
Egypt	No	?	105
India	No	No	115

The table indicates some relationship between response time and United Nations Development Index rank although there are outliers like Canada. In all fairness, Canada responded within 10 days with a question about how many respondents were required and the system eventually produced a very thorough response. France also responded promptly, but indicated only a questionnaire in French would be acknowledged, A French translation was prepared and sent a month later but no response was received as of mid June 2002. It is also clear that except for the Germans which do not use GIS in their census efforts that those countries not using GIS are more likely not to respond or respond later. The usually efficient Dutch did not respond contact with the leading GIS center in Holland (University of Utrecht) elicited the information that the Dutch do not use GIS in the census efforts and last conducted a census in 1971. They have however accurate postal code GIS. Also those countries low on UNDI are less likely to use GIS. Non-responses from Denmark, Japan and Portugal were also surprising. Follow up with academic institutions in these countries resulted in forwarding of the survey to GIS experts in census authorities and the information that GIS is used in census efforts in all three countries, the completed surveys were not available by mid-June however.

## 8. Salient Points

### 8.1 Census Authority Survey

Several salient points can be learned from study of the responses to the questions. One is that GIS use is becoming common place among census authorities in developed countries. Another is that a few countries that have systems of registers and require registration when citizens move from one locality to another have not adopted GIS in site of technological advanced status. These nations include Singapore, Germany, Holland and Iceland. In the case of Iceland most of the population is concentrated in one City.

With respect to the census frequency, most countries have copied the U.S. method set down in the constitution of a decennial census. However, Finland conducts a census every year while New Zealand uses 5 year intervals and Sweden uses 5 years and 15 year intervals. Holland last conducted a census in 1971 and Germany last conducted a census in 1983.

As to the collection of various types of data most countries collect educational attainment and residential living data, fewer collect income data and very few collect information about business establishments. Finland asks

the most complete set of questions.

As to the geographic subdivisions that data is collected for, most countries have something equivalent to census tracts and blocks used in the U.S. typically 100 people approximately reside in these enumeration areas the use municipalities while several countries have data for individual residences such as Switzerland, Finland, Norway, U.K. and Sweden. Few countries have postal addressing links, England and Holland being exceptions.

Privacy is protected by all countries to some extent, some like aggregating the data to municipalities, mostly aggregating it to groups of 100 or more (so % data cannot be ascribed to a single individual) a few such as Sweden have 5 or more respondents. Duration of use of GIS varies greatly from a high 27 for Sweden, 25 years for the U.S. and 15 years for Canada to only 2 years for Brazil and in the developmental stages in Taiwan and Japan..

Most countries found GIS very useful and most had had significant interest in use of GIS expressed. The mode for utility was a 10, while the mode for interest was a 9.

All countries that responded released data publicly in some form, some on CD, some over the Internet. Many will sell digital data commercially.

The languages the data was available in varied. In France it is exclusively in French, In the Latin American Countries it is exclusively Spanish, except for Brazil which has data in Portuguese and English. Data in English is also available in Norway, and Germany. And Canada (French also for Canada).

Use of the Internet to disperse data was less common with the U.S., New Zealand, and Norway being leaders. Most agencies preferred to sell data with costs ranging from a low for the U.S. of approximately \$300. Switzerland was notable in setting a rate of .0002 Swiss franc per hectare a unique approach made possible by the use of a 50 meter grid as to track data. The U.K. estimated that it's nationwide GIS (including both census and topography) would be sold for a modest 40 million pounds!

GPS use was very rare with only Brazil and Australia really using GPS in census activities, probably because of their sprawling size.

## 9. Mapping Authority Survey Responses

Scales of Maps prepared ranged from Switzerland which had GIS data for a 50 meter grid to Australia which only had data at scales of 1:100,000. The U.S. uses a scale of 1:24,000 while England uses a 1:500 scale.

Typical features portrayed on the topographic maps include political boundaries, Roads and rail lines,

hydrographic, counters. Some maps portray land-use such as U.S. and German, some portray building footprints such as German, U.K. and Swiss. Some have unique features portrayed such as the fence lines on Australian maps or the individual fruit trees on Swiss maps.

Maps were updated every 1-5 years in the United Kingdom, every 5 years in New Zealand every 5-20 years in Australia and on average every 28 years in the USA.

Some countries mapped residences such as Great Britain, Norway, Germany and Switzerland

Few countries mapped business locations specifically only Britain and Switzerland.

Most countries had a national system of postal addressing in Spain, Germany, Holland, and Great Britain that system is in the GIS, It is not in a GIS in the USA.

Most countries contacted used GIS with the possible exceptions of Egypt and India (non-respondents who are largely relying on colonial era mapping).

The number of years that GIS was in use varied from more than 30 in the USA and Canada to 30 in the U.K. to 18 in Spain to 15 in Germany.

Cost of the data ranged from \$1,500 for New Zealand to 40 million pounds for the U.K.

The USA, Canada and Switzerland were among the few countries with GIS data available over the Internet.

Use of remotely Sensed imagery was common although less common than use of aerial photography. However most nations did not have available digital aerial photography, Switzerland and Germany were exceptions however.

## 10. Respondent information

Information used to contact the National Census Authorities is summarized below.

Country Name	Agency Name	Web Site	Contact Person	E-mail	Address	Phone	Fax
--------------	-------------	----------	----------------	--------	---------	-------	-----

Argentina: <http://www.indec.mecon.ar/default.htm>  
[mces@indec.gov.ar](mailto:mces@indec.gov.ar)

Australia: <http://www.abs.gov.au/client.services@abs.gov.au>

Austria: <http://www.oestat.gv.at/>

Belgium: Institut national de Statistique  
<http://www.statbel.fgov.be/> Pierre  
Jamagnedsk@statbel.mineco.fgov.be "44 rue de Louvain,  
1000 Bruxelles, Belgium" 00 32 2 5486597 00 32 2  
5486626 5/27/2002

Brazil: Fundacao Instituto Brasileiro de Geografia e  
Estatistica  
[http://www.ibge.gov.br/english/default  
.phpibge@ibge.gov.br](http://www.ibge.gov.br/english/default.phpibge@ibge.gov.br)  
Rua General Canabarro 706 - 2 andar 0055  
(021)5692043 0055 (021) 2348480 4/30/2002

Canada: Statistics Canada statcan.ca/English Robert  
Parenteau [Robert.Parenteau@stat.can](mailto:Robert.Parenteau@stat.can)  
"Tunney's Pasture, Jean TaLor Bldg, 120 Parkdale,  
Ottawa, Onterio" 613-951-2958 613-951-0569 "April,  
2002" 6/4/2002

Chile: <http://www.ine.cl/> Spanish

China (PRC):  
[http://www.stats.gov.cn/english/index.  
htmceco@mx.cei.gov.cn](http://www.stats.gov.cn/english/index.htmceco@mx.cei.gov.cn)

Czech Republic:  
<http://www.czso.cz/eng/angl.htm>  
Tomál Bládek [MLADEK@gw.czso.cz](mailto:MLADEK@gw.czso.cz) 3/22/2002

Denmark: Statistics Denmark  
[http://www.dst.dk/dst/dstframeset\\_1024  
.en.asp](http://www.dst.dk/dst/dstframeset_1024_en.asp) michael.deggau@destatis.de 4/16/2002

Egypt: <http://www.czso.cz/eng/angl.htm>  
gisc@capmas.gov.eg

Finland: Statistics Finland  
[http://www.stat.fi/index\\_en.html](http://www.stat.fi/index_en.html)  
Ulla-Maarit  
SaarinenUlla-Maarit.Saarinen@stat.fi FIN-00022  
STATISTICS FINLAND 358 9 17 341 358 9 1734  
32515/28/2002

France:  
[http://www.insee.fr/en/home/home\\_page.  
asprenseignements@insee.fr](http://www.insee.fr/en/home/home_page.asprenseignements@insee.fr) 3/13/2002  
French

Germany [http://www.destatis.de/e\\_home.htm](http://www.destatis.de/e_home.htm) Michael  
Deggau [michael.deggau@destatis.de](mailto:michael.deggau@destatis.de)  
4/14/2002

Hong Kong Census and Statistics  
Department <http://www.info.gov.hk/censtatd/> SO  
Shui-sing [cp2\\_1@censtatd.gov.hk](mailto:cp2_1@censtatd.gov.hk) "7/F, Kai Tak  
Multi-storey Carpark Building, 2, Concorde Road,  
Kowloon, Hong Kong" 852-27168008 852-27160231  
4/19/2002

Hungary:  
[http://www.ksh.hu/pls/ksh/docs/index\\_e  
ng.htmlbelane.takacs@ksh.gov.hu](http://www.ksh.hu/pls/ksh/docs/index_eng.htmlbelane.takacs@ksh.gov.hu)

Iceland: Statistics Iceland  
<http://www.statice.is/> Magnus S. Magnusson  
Magnus.Magnusson@hagstofa.is "Statistics Iceland,  
IS-150 Reykjavik, Iceland" 354-560 9836 354-562  
8865 5/31/2002

India: [http://www.nic.in/stat/  
webmaster@www.nic.in](http://www.nic.in/stat/webmaster@www.nic.in)

Israel: Israeli Central Bureau of  
Statistics <http://www.cbs.gov.il/engindex.htm>  
Shahar Katz [shahar@cbs.gov.il](mailto:shahar@cbs.gov.il) 4/10/2002  
5/20/2002

Italy: ISTAT - National Institute of  
Statistics <http://www.istat.it/homeing.html>  
<http://www.istat.it>  
<http://www.geodati.com> Fabio  
Crescenzi [crescenzi@istat.it](mailto:crescenzi@istat.it) Via A. Rava 150 00142  
Roma Italy: 39065414980 39065943011 5/27/2002

Japan:  
[http://www.stat.go.jp/english/index.ht  
mtokyo.iaos@stat.go.jp](http://www.stat.go.jp/english/index.htm)

Korea: [http://www.nso.go.kr/eng/"webmaster@nso.go.kr  
webmastre@nsohp.nso.go.kr"](http://www.nso.go.kr/eng/webmaster@nso.go.kr)

Luxembourg: <http://statec.gouvernement.lu/> French

Malaysia: <http://www.statistics.gov.my/>

Mexico: <http://www.inegi.gob.mx/difusion/ingles/portadai.html>

Netherlands: <http://www.cbs.nl/en/infoservice@cbs.nl>

New Zealand: Statistics New Zealand  
<http://www.stats.govt.nz/> Zane Colville  
[zane\\_colville@stats.govt.nz](mailto:zane_colville@stats.govt.nz)  
"Private Bag 4741, Christchurch 8001, New Zealand" 64-3-374-8756 64-3-374-8723 5/16/2002

Norway: Statistics Norway [www.ssb.no](http://www.ssb.no) Mr. Lars Rogstad  
[Lars.rogstad@ssb.no](mailto:Lars.rogstad@ssb.no) 4/13/2002  
4/16/2002

Poland: <http://www.stat.gov.pl/english/index.htm>  
[tmbiwsek@stat.gov.pl](mailto:tmbiwsek@stat.gov.pl)

Portugal: [http://www.ine.pt/index\\_eng.htm](http://www.ine.pt/index_eng.htm)  
[mai.telepac.pt](mailto:mai.telepac.pt)

Russia: <http://www.gks.ru/eng/stat@gks.ru>

Singapore Singapore Department of Statistics  
[singstat.gov.sg](http://singstat.gov.sg)  
Ms. Yap Lay Hoon  
[Hooninfo@singstat.gov.sg](mailto:Hooninfo@singstat.gov.sg)  
"100 High Street #05-01, The Treasury, Singapore 179434" 65-6332 7754 65-6332 7174 3/13/2002

South Africa <http://www.statssa.gov.za/>

Spain: <http://www.ine.es/>

Sweden: "Statistics Sweden Statistiska centralbyran"  
[www.scb.se/eng/BoJustussonbo.Justusson@scb](http://www.scb.se/eng/BoJustussonbo.Justusson@scb)

[.se](mailto:se) "Box 24300,S-104 51 Stockholm, Sweden"  
4/14/2002 4/17/2002

Switzerland Swiss Statistical Office  
<http://www.statistik.admin.ch/eindex.htm>  
Stefan Winter [Stefan.Winter@bfs.admin.ch](mailto:Stefan.Winter@bfs.admin.ch)"OFS, Place de l'Europe 10, 2010 Neuchatel, Switzerland" 41 32 713 62 57 41 32 713 65 60 4/13/2002 4/25/2002

Taiwan: Census Bureau  
[http://www.dgbase.gov.tw/english/dgbase\\_e0.htm](http://www.dgbase.gov.tw/english/dgbase_e0.htm)  
Kuo-Hua Luo [robert@emc.dgbase.gov.tw](mailto:robert@emc.dgbase.gov.tw) "2, KwangChow Street, Taipei City, Taiwan, R.O.C" 886-2-29187176 886-2-23751747 5/21/2002

United Kingdom: Office of National Statistics  
( Geography) <http://www.statistics.gov.uk/>  
Hayley Butcher  
[Hayley.Butcher@ons.gov.uk](mailto:Hayley.Butcher@ons.gov.uk)"Segensworth Road, Fareham, Hampshire, PO15 5RR, England" 44 (0)1329 813581 4/12/2002 5/1/2002

United States U.S. Census Bureau  
[www.census.gov/main/www/cen2000.html](http://www.census.gov/main/www/cen2000.html)  
Leo Dougherty  
[leo.bernard.dougherty@census.gov](mailto:leo.bernard.dougherty@census.gov)  
"U.S. Census Bureau, Washington, D.C. 20233" 301-457-1128 4/22/2002

Uruguay: <http://www.ine.gub.uy/>

## 11. Conclusions

GIS use is becoming widespread in the Census authorities of the World. It is even more common in the national mapping authorities, although the specific organization responsible for national mapping varies. The countries surveyed as to use of the technology by the census authority can be divided into those which are integrating geodemographic data into national multi-purpose cadastres these include the Swiss, Swedes, Norwegians and British, Those that follow the U.S. model of a separate census based GIS with street centerlines and census enumeration districts but not features like building foot-prints or actual residential locations geo-coded these include Canada, Australia, New Zealand, Israel, Belgium, Finland, Brazil. Then there are the countries with detailed registers of population that enable them to track their residents on an essentially continuous basis and where maps are not in use these include Germany and Holland and Singapore. Lastly there are countries that are not at the level of technological sophistication to use GIS in governmental activities like census taking. Since most countries surveyed were in the top 20% of nations in terms of development this was not a common problem however

for Egypt, India and China it is.6.Also this may explain lack of response from eastern Europe and Russia and Latin America except for Brazil. Missing data from France and Latin America reflect communication difficulties or national chauvinism and possibly developmental lags in Mexico and recent poverty in Argentina. Over all, the results show a growing body of geodemographic data and spatial infrastructure data that can be used in marketing studies and locational applications as well as by social scientists and urban planners. As countries increasingly adopt the technology and standardize the content, this source of data will become a mainstay of GIS analysis throughout the world in the coming century.

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# Utilize E-Commerce to Further Open the Door of China

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China

## Abstract

In the end of 2001, China re-entered the World Trade Organization, which means a pivotal step to further open. On the other hand, the advent of Internet makes it easier, cheaper, faster to find and communicate with potential customers and partners across the globe. The e-commerce, combined with the WTO entry, seems to become a powerful wagon for those foreign companies that have long salivated over China's huge market.

In the beginning of this paper, we briefly point out the huge potential of e-commerce in the country. Then we proceed to provide you with a picture of the e-commerce circumstances in China. At last, we give some suggestions to foreign companies on how to make a go of e-business in China.

## 1. Introduction

More than 2,000 years ago, invading tribes from the north were repulsed by the 1,500-mile Great Wall, built by vassal states of the Qin Dynasty to protect the fertile lands of China.

At the beginning of the 21st century, the walls that separate the Chinese economy from the rest of the world are poised to fall a notch with China's re-entry into the World Trade Organization. With that opening, tariffs will be lifted and trade barriers are about to fall. Certainly, the WTO will open China's market in a way they've never been open before. Besides the entry, Internet, one of whose promises is to make it easier, cheaper, and faster to find and communicate with potential customers and partners across the globe, seems to become another powerful wagon for the foreign companies to open the door of the waken-up dragon.

With the combination of Internet and China's entry to WTO, foreign companies will now have an historic opportunity to get into the largest potential market of the world and reap tremendous rewards----many foreign e-businesses hope to utilize the Internet to tap into vast new markets and to link to new business partners.

China and its massive market, have long been the envy of the business community, ranging from huge international consumer goods companies to feisty entrepreneurs with an idea to sell or a niche to exploit. Nowhere is the potential for gain more evident than the lucrative Internet business.

Although China currently comprised only 4.2 percent of all Internet users, while trading through e-commerce in China came to less than 0.6 percent of the worldwide

volume, with one-fifth of the world's population, China is viewed as one of the greatest untapped Internet commerce territories —its Internet users could grow from an estimated 17 million now to 60 million by 2005, and its strong manufacturing base combined with WTO accession will make it a major e-commerce market. According to the WTO EMarketer. Inc., in New York, estimates of B2B e-commerce revenues in China will grow from \$1.5 billion this year to \$21.8 billion by 2004. International Data Corp predicts that China's Internet commerce revenues will get 70.1 billion by 2004.

The development of e-commerce gets strong support from the government, too. On August, 2000, at the World Computer Congress -- a gathering in Beijing of Internet entrepreneurs and regulators from 70 countries -- President Jiang Zemin said that "virtual reality is changing the way people produce, learn and live," and the "melding of the traditional economy and the information technology will provide the engine for the development of the economy and society in the 21st century."

Given the huge potential e-commerce market in China, it makes great sense for foreign companies with a desire to do business in China to use e-commerce to roll out their e-globalization strategies in that large country. But have patience! They should have a clear and specific understanding of the e-commerce circumstances in China to determine correct strategies of launching a successful e-commerce operation. Only in that way, can the foreign companies roll out their e-globalization strategies in China and can they further open the door of China's market.

We will discuss these problems one by one in the following of the paper

## 2. Is China ready for e-commerce?

To launch a successful e-commerce operation in China, foreign companies should first have a clear picture of the circumstances of e-commerce in China. Let's discuss them at length.

### 2.1 The Culture of the Market

First and foremost, there is no one Chinese market. Management gurus stress that it is key to realize that companies are working in cultures, not markets. China is one culture and many cultures at once. It is beyond the scope of this paper to provide a cultural map of China, but part of any preparatory work for e-business investment in China should include a series of briefings

on the complexities of China's many cultures and on the "rules of the game" in the Chinese market.

## 2.2 Growth of the Internet

The exponential growth that has occurred in the number of Internet users in China makes it a prime target for foreign investment in e-commerce. In 1995, there were fewer than 50,000 Internet users in China. At the beginning of 1998, there were some 2.1 million users. By the end of 2003, the China Internet Information Center projects there will be 20 million users.

## 2.3 The Legal Framework

The fact is, there is no legal framework. However, work on an overall legal framework is underway. Some rules are expected to be published on a gradual basis, following China's entry into the WTO. In addition, center of computer and microelectronics industry and development (CCID) is collaborating with the taxation authorities to draft tax regulations.

Some regulations that foreign companies should keep in mind include a licensing requirement for all dotcoms, strict limits on direct foreign investment and a mandate to keep user records that are surrenderable to the government upon request. Another problem is the regulations now in place regarding encryption. Initially foreign businesses were required to register the encryption products they used in China. This would have given the state the ability to decode traffic passing through the Internet between branches of the same business. The state has since backed down on this requirement. But Chinese firms are still forbidden to use any foreign-made standalone encryption products. They may only use Chinese-made products registered with the new State Encryption Management Commission. This gives the state a means of monitoring computer traffic.

## 2.4 Payment method

Government restrictions aside, China's e-commerce is also handicapped by a lack of convenient payment methods. In a survey "Greater e-China Insights," conducted by Cheskin Research and Chinadotcom Corporation, only 30 percent of mainland Chinese respondents said that they have a credit card. The most common payment method for online purchases in mainland China is cash-on-delivery (COD).

## 2.5 Trust Issues

Respondents to the survey were also distrustful of companies that exist only in cyberspace without a brick-and-mortar counterpart. According to the study, few Chinese would make a purchase from an e-tailer that they had never heard of before.

Since the Greater Chinese online market is just in its infancy, it's even more critical to pay attention to online trust. As technology penetrates global markets, access to e-commerce won't be the issue, creating loyal

relationships through service, authenticity, and trust will be key. There is still a long way for China to build a certificate of authentication system and construct a healthy credit system.

## 2.6 Delivery services

E-commerce is not all about the technology. You have to be able to move things around speedily and in a flexible way to meet the customers' needs. The transportation infrastructure is not established. Even in the prosperous coastal provinces in the East, transportation can be very problematic. While packages in the United States can be shipped cross-country in a matter of days, for example, in China the roads--or lack thereof--mean that, even if B2B e-commerce were to take off, there is no efficient way to deliver products.

## 3. How to make a go of e-business in China?

Despite many barriers, potential of China's e-commerce market is huge and growing. But a growing market is irrelevant unless you develop a strategy to make it work for you. Markets do not wait. Your success all depends on your strategy and your understanding of the power of e-commerce. Besides translating your web site to Chinese and providing contents that appeals local culture, here are some other suggestions for foreign companies to launch a successful e-commerce in China.

### 3.1 Have a good understanding of China's e-commerce circumstances

A foreign e-commerce company should have a good understanding of China's e-commerce circumstances: the telecom infrastructure, the number of people who often surf the net and the growth of this population, the on-line payment methods, people's perspectives about e-commerce, to what extent the people accept e-commerce, the legal framework, the trust issues of on-line business, the commercial culture, the transportation infrastructure, the delivery services, etc. All of these are important for a foreign e-commerce company to make a correct strategy.

### 3.2 Strategic Planning: The Initial Stage

Most e-commerce companies can no longer afford to sacrifice capital on ill-planned experiments.

The path to a successful e-business strategy for Mainland China starts with the basic tenet of all good strategies—planning. This means that 12 months prior to your launch date, you should identify a China team to set goals, draft a strategy and map out the enterprise architecture to attain your business objectives. Who should be involved in this initiative? We recommend that they be key representatives of the marketplace (such as customers), those with execution capability (such as IT), and finance people. We've seen a maximum of four team leaders with 15 managers focused on project management,

and a minimum of eight managers from IT and customer service involved at any one time.

### 3.3 Establish an appropriate company website

Firstly, the content of the company website should be expressed in Chinese. Although translating the website into Chinese is a demanding task—besides the translating machine, language experts probably have to stand by to assist the machine. Attracting customers is the first step of success. Compared with foreign language websites, websites in Chinese have an obvious advantage. It's hard to imagine customers or potential business partners would be willing to spend more time on an foreign language website (even he knows or master that language). It will be costly if company translates itself. There are many professional companies offering the solution for website translation. So e-commerce company can outsource the task of translation. But the company still need to supervise the results of translation.

Besides the local language content, what is more important is to provide localized products and services. That is, the products and services should adapt to Chinese culture, which means a lot of effort "below the web".

### 3.4 Consult law specialists

Equally important will be your choice of an international law firm with proven China expertise. We also advise employing an outside consultant to serve as an overall facilitator and troubleshooter in China. They should be responsible for briefing the head office on the complexities of the Chinese market.

### 3.5 Find the Right Ally

Leverage local relationships. The multicultural nature of global business creates a degree of complexity that cannot be easily satisfied just by establishing a Web presence.

Businesses cannot underestimate the value of a local presence and the insight that having an on-site window into the culture represents. Local partners can help provide the answer to problems of trade regulation, and tariffs, and legal and regulatory complexities. Foreign e-commerce companies can use network of local offices and distributors to fulfill orders, to figure out the pricing in local currency, and to arrange payment by the preferred method.

Partnering with Chinese companies is smart because:

(1) It offers benefits that go well beyond easing compliance with Chinese regulations. Business in China, as in many Asian countries, is built on trust and enormous amounts of personal contact. As a result, B2B e-commerce can be a tough sell. Finding a partner in China can help resolve some of those cultural issues.

(2) If you anticipate substantial technology costs or substantial operational expenses like brand recognition (such as advertising), then it would make sense to

consider a partnership or alliance with a Chinese counterpart who already has a related business vehicle up and running. For example, consumer-oriented offerings require heavy investment in branding because of the fight for eyeballs in a crowded market. By choosing the partnering route, you avoid spreading your resources thin, and you're building expertise for the future.

Since a joint venture partner will have knowledge of the market, commercial network and political savvy that you, both as a newcomer and outsider, lack, you can expand your business opportunities network and better position yourself for the anticipated e-commerce growth in China. Make sure that your partner is selected with all due diligence.

### 3.6 Others

Besides what we have illustrated above, foreign e-commerce company should be cautious about the followings:

(1) Provide as many payment methods as possible. Since the payment system is not so advanced that foreign e-commerce companies should provide payment methods at different levels.

(2) Pay attention to trust issues.

(3) Outsource the delivery services to international cargo companies, such as DHL, UPS, etc.

## 4. Conclusions

China is viewed as one of the prosperous e-commerce market, and companies first investing in such market will undoubtedly take first-mover advantage. Empowered by the convenience and cost benefits that the web is designed for, and with correct understanding of e-commerce, foreign e-commerce companies who are patient and willing to play by China's complex rules can find a bright future.

## References

- [1] Mark W. Vigoroso, "E-tailers: Globalize with Caution," E-Commerce Times, November 2001.
- [2] Barry Silverstein, "Going Global With Internet Marketing," ClickZ, August 2001.
- [3] Anne Chen, "Scaling the wall," eWeek, June 2001.
- [4] International Data Corp.'s Internet Commerce Market Model, V7.1, March 2001
- [6] Ralph F. Wilson and Kevin Zhong, "E-Commerce in China," ClickZ, April 2001.
- [7] "Consumer E-Commerce in China," Survey by BDA China Limited, August 2000.

# Current Information Technology Infrastructure for E-Business

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## Abstract

The e-business application can be considered as a new generation of computer information systems in the Internet era that needs the support from a solid information technology infrastructure including strategic objectives, physical components, and operational management. A survey was conducted to investigate some current practices and its implications of the information technology infrastructure existed in thirty organizations from ten different industries located in California. These organizations reported that they have implemented two or more e-business applications using the different types of the network operating systems and network security protections. The most used e-business development method is still the traditional in-house development method that offers the best management planning and controlling strategy to align the overall business and information technology objectives together. The system integration, e-mail system management, and customer relation management have gained their importance in the routine operating functions at the information technology department.

## 1. Introduction

The constant improvement of the powerful and inexpensive microcomputers and the advancement of the distance networking communication technologies have pushed the birth of the Internet. On the other hand, the invention and usage of Hypertext Markup Language (HTML), Hypertext Transfer Protocol (HTTP), Transmission Control Protocol and Internet Protocol (TCP/IP) have produced the World Wide Web (WWW) [1] [2]. Consequently, the combination of the Internet and WWW has established a special environment for a new communication system that enables the individuals and organizations to create, transfer, locate, and view multimedia documentation between locations without any time and distance limitation [3] [4].

The individual and organization have quickly recognized the potentials and captured the benefits that could be offered by that new Internet and World Wide Web

communication system. Those individual and organization have then developed the Internet economy or electronic economy (e-economy) that utilizes the enormous capability and power of the Internet and World Wide Web communication system to conduct different types of business named electronic business (e-business).

An e-business not only can offer the individual and organization a brand new channel of conducting business through the electronic network, but also can increase the efficiency and effectiveness of the routine operations to gain competitive edge in this information era. Meanwhile, like any traditional computer information system, a winning e-business application definitely requires the support from a solid information technology infrastructure that includes strategic objectives, physical components, and operational management [5] [6] [7] [8].

The major objective of this research paper is to present some preliminary survey results of the information technology infrastructure that have been utilized by a sample of the thirty organizations located in California. The sample has ten different types of the organizations including consulting, education, government, manufacturing, health, pharmaceutical, real estate, retail, service, and utility.

## 2. The Survey

An appropriate questionnaire was developed in an attempt to determine some answers related to the current information technology infrastructure for the organizational e-business applications. Specifically, the present practices of the following questions were to be sought:

1. How many and what types of organizations are utilizing the e-business applications?
2. What types of the e-business applications are being implemented in the organizations?
3. What types of the network operating systems are being installed for the e-business applications in the organizations?

4. What types of the e-business security implementations are being employed by the organizations?
5. What types of the development methods are being adopted for the e-business applications in the organizations?
6. What types of the functions related to the e-business are being supported by the information technology department in the organizations?

A three-page questionnaire was mailed to a sample of randomly selected organizations that are located in the three areas including Los Angeles, Silicon Valley, and Sacramento of California. Thirty properly completed questionnaires have been returned by the responding organizations that provide the data source for the analysis and discussion presented in this paper.

### Users of The E-business Applications

On the questionnaire, the organizations were asked to indicate their total annual revenue, total number of employee, and the number of years using a network. The summarized results are presented in Table 1. It is interesting to note that the total annual revenue of the responding organizations ranges from eight million dollars to twenty six billion dollars, and the total number of employee ranges from thirty five individuals to one hundred and thirty thousands. These two statistics imply that the e-business applications are used in the big business organizations as well as in the small ones.

**Table 1: Characteristics of the Responding Organizations (n=30)**

Characteristics	Low Value	Median Value	Average Value	High Value
Total Revenue (millions)	\$8	\$1,000	\$5,765	\$26,000
Total Employee (thousands)	0.035	4	20.89	130
Year of Network Use	2	12	12.92	35

The only usage difference of these two types of organizations is indicated by the number of years using a network. The big business organizations have started the network communication as long as thirty-five years ago that is way before the creation of the Internet. On the contrarily, the small business organizations could enjoy the inexpensive network communication is solely due to the birth of the Internet. It is not surprising that the average number of years using a network is around thirteen years that is closely equal to the number of years for commercial usage of the Internet. The Internet does

level the playing ground in terms of telecommunication for the business organizations regardless of their size.

**Table 2: Types of Organizations Using the E-business (n=30)**

Industry	Number of Using E-business
Consulting	6
Education	2
Government	5
Manufacturing	6
Health	1
Pharmaceutical	1
Real Estate	1
Retail	1
Service	3
Utility	4

The survey asked the responding organizations to specify their primary business activity. Table 2 presents the industry background of the organizations that have implemented the e-business applications. The sample has ten different types of the organizations including consulting, education, government, manufacturing, health, pharmaceutical, real estate, retail, service, and utility.

### E-business Applications

The responding organizations were asked to indicate every type of their e-business application. Table 3 summarizes the current practices of the various e-business applications implemented by the responding organizations.

**Table 3: E-business Applications (n=30)**

Application	Number Responding	Percentage Responding
Intranet	30	100%
Portal	16	53%
Business -to- Business	15	50%
Business -to- Customer	23	77%
Customer-to- Customer	5	17%
E-mail	28	93%
Electronic Data Exchange	17	57%
Others	3	10%

It appears that the e-business applications being most widely used are Intranet, e-mail, and business-to-customer. The e-business applications such as electronic data exchange, portal, and business-to-business are also used by more than fifty percent of the responding organizations. Whereas, the only e-business application named customer-to-customer appears to be not as widely used by the responding organizations.

Apparently, every responding organization has installed more than one e-business application. The three most important intensions of the e-business applications are to increase the organizational productivity, to facilitate the organizational communication, and to create a sales channel. The less popular intensions of the e-business applications are to exchange information between business partners and to establish a online gateway for the Internet users. The least usage of the e-business application is building a public auction market on the Internet.

### Network Operating Systems Used for the E-business Applications

The questionnaire, also, asked the responding organizations to identify the names of the network operating systems installed to run their e-business applications. Table 4 illustrates the statistics of network operating systems used for the e-business applications in the responding organizations.

It is not surprising that the Windows NT developed by Microsoft is the most popular network operating systems used by ninety seven percent of the responding organizations. The Unix created by AT&T is the second popular network operating systems that have been used by seventy seven percent of the responding organizations. The less popular network operating systems include Linux, Sun Solaris, and HP-UX.

**Table 4: Network Operating Systems Used for E-business Applications (n=30)**

Network Operating Systems	Number Responding	Percentage Responding
Window NT	29	97%
Unix	23	77%
Linux	11	37%
Sun Solaris	14	47%
HP-UX	8	27%
Others	6	20%

There are two interesting facts related to the two popular network operating systems that dominate the market. First, the criteria used by responding organizations to purchase the network operating systems might include the factors such as the software performance records, the amount of support, and the availability of skillful experts.

Second, the responding organizations might have separated networks for their different e-business applications since they install more than one network operating systems to fulfill the special requirements.

### Security Implementations for the E-business Application

In the questionnaire, the responding organizations were asked to indicate the types of the security implementation that have been installed for protecting their e-business applications. Table 5 provides a summary of the types of the security implementation for which the responding organizations have used.

The responding organizations do emphasize their network security, data integrity, and information privacy since they have installed more than one security scheme. It appears that the firewall is the most commonly used security method to block the intruders and unauthorized users from accessing the extranet and/or intranet applications. More than fifty percent of the responding organizations utilize the private key and public key as a safeguard measurement to scramble the data and information during the message transmission between the sender and the receiver.

**Table 5: Security Implementations for the E-business Application (n=30)**

Security Implementation	Number Responding	Percentage Responding
Firewall	27	90%
Electronic Signature	10	33%
Private Key and Public Key	16	53%
Secure Electronic Transaction	11	37%
Digital Certification	8	27%
Other	4	13%

The security methods such as electronic signature, digital certification, and secure electronic transaction are less used by the responding organizations. This result may imply that the nature of these three methods is not for the purpose of safeguard the network. The electronic signature and digital certification that involves a payment to the third party are especially for the safe transmission of an important documentation and/or sensitive information. Whereas, the secure electronic transaction is mainly for the financial transactions between the business organizations and customers using a secured private network.

## Development Methods for E-business Application

The responding organizations were asked to identify the e-business application development method used in their organizations. Table 6 provides a summary of the development methods that have been utilized in implementing some of the e-business applications in the responding organizations.

The responding organizations overwhelmingly favor in-house development method over the other two development methods named outsourcing and off-the-shelf package in every types of the e-business applications. Apparently, the responding organizations consider every one of their e-business applications as a vital and strategic computer information system. Therefore, the organizations need to have an internal team with profound business knowledge and information technology skills to plan, create and control their e-business applications in order to achieve its predetermined objectives for competitive advantages.

**Table 6: Development Methods for E-business application (n=30)**

Type	In-house	Outsourcing	Off-the-shelf Package
Web Page	26 (87%)	6 (20%)	4 (13%)
Electronic Data Interchange	14 (47%)	5 (17%)	2 (7%)
Intranet	27 (90%)	4 (13%)	4 (13%)
Business-to-Customer	18 (60%)	5 (17%)	2 (7%)
Business-to-Business	13 (43%)	3 (10%)	2 (7%)
Customer-to-Customer	4 (13%)	1 (3%)	1 (3%)
Call Center	11 (37%)	3 (10%)	8 (27%)

The outsourcing development method is slight over the off-the-shelf packages that have been used by the responding organizations in every category except the call center. This result indicates that most of the responding organizations have their own special requirements in the e-business applications. These special requirements cannot be fulfilled by a generalized off-the-shelf package. On the other hand, the e-business application in a call center is related to the call distribution system that can be provided by a prepackaged private branch exchange telephone system for more efficient operation and less investment risk.

## Functions Supported by Information Technology Department

The responding organizations that have an information technology department or division were asked to indicate the functions performed by their information technology department in the current information era. Table 7 presents a summary of the types of the tasks executed by the information technology department in the responding organizations.

**Table 7: Functions Supported by Information Technology Department (n=30)**

Functions	Number Responding	Percentage Responding
Technical System Development	28	93%
Technical System Maintenance	28	93%
Off-the-shelf Package Evaluation	25	83%
System Integration	27	90%
Outsource Contract Management	21	70%
Customer Relationship Management	22	73%
E-business Development	20	67%
E-business Maintenance	20	67%
E-mail system Management	27	90%
Database Management	28	93%
Data Warehousing/Data Mining	22	73%
Network Management	25	83%
Internal User Support	25	83%
Other	3	10%

The five functions including technical system development, technical system maintenance, system integration, e-mail system management, and database management have been selected as the most commonly performed tasks in the responding organizations. This result indicates some interesting points. First, the traditional functions such as system development, system maintenance, and database management are considered by ninety three percent of the responding organization as their routine duties. Second, the only function related to the e-business application is e-mail system management. Where the information technology department takes the responsibilities of managing the operations of e-mail server, controlling the storage area, and preventing the virus, etc. Third, the responding organizations do not adopt the new development policy to replace the old information systems. On the contrary, the responding

organizations emphasize the system integration approach to merge the old and new computer information systems by using open standard and middleware.

The off-the-shelf package evaluation, network management, and internal user support are ranked by eight three percent of the responding organizations as the next group of most commonly performed tasks in their information technology department. It is interesting to note that the majority of the responding organizations are not likely to use the off-the-shelf package for their e-business applications as illustrated in the previous Table 6. On the other hand, the information technology department of the responding organizations does often perform the off-the-shelf package evaluations for other types of computer information systems as indicated in the current Table 7.

Seventy three percent of the responding organizations have reported that the customer relationship management, data warehousing, data mining, and outsource contractor management have become part of the routing operations performed by their information technology department. This is not a surprising result since the major purpose of data warehouse and data mining is to accomplish the personalization or mass customization for the e-business applications. In addition, the online customers of any e-business application do periodically encounter technical difficulty and requires the assistance from the skillful staff member of the information technology department. The outsourcing contractor management also has gained its important status since it is a quick alternative method to obtain knowledgeable individuals by the information technology department for instant problem solving in this fast changing environment.

### 3. Conclusion

The advance information technology has created a new type of economy named electronic-economy or e-economy that has pushed the business society to a new frontier in the last decade of twenty century. This e-economy has leveled the playing ground for every types of organization to conduct its business functions regardless its size, resource, location, and time.

It is important for any organization to properly obtain this incredible power by developing the e-business applications on time for the purpose of increasing its internal productivity, reducing its operating costs, or enhancing its customers and suppliers relationship in this e-economy environment. On the other hand, it is also essential for the organization to establish a well-structured information technology infrastructure in order to backing its business applications.

A survey was conducted to investigate some current practices and its implications of the information technology infrastructure existed in the organizations. Thirty responding organizations from ten different types

of industries reported that they have implemented two or more e-business applications using the different types of the network operating systems and network security protections. The most used e-business development method is still the traditional in-house development method that offers the best management planning and controlling strategy to align the overall business and information technology objectives together. The system integration, e-mail system management, and customer relation management have gained their importance in the routine operating functions at the information technology department.

### References

- [1] Amor, Daniel, *The E-business (R)evolutio*, Prentice Hall PTR, 2000.
- [2] Deitel, H. M., P. J. Deitel, and K. Steinbuhler, *e-Business and e-Commerce for Managers*, Prentice Hall PTR, 2000.
- [3] Gerrard, M., "Challenges in Aligning E-business Strategy and IT Planning," *Gartner Group*, December 1999.
- [4] Menasce, Daniel A. and Virgilio A. E. Almeida, *Scaling for E-Business: Technologies, Model, Performance and Capacity Planning*, Prentice Hall PTR, 2000.
- [5] Mesenbourg, Thomas, "Measuring Electronic Business; Definitions, Underlying Concepts, and Measurement Plans," *U.S. Census Bureau*, June 2001
- [6] Plant, Robert, *eCommerce: Formulation of Strategy*, Prentice Hall PTR, 2000.
- [7] Radding, Alan, "Pressure Grows for E-Business Infrastructure," *Information Week*, September 2000.
- [8] Schutte, Dave, "Turning E-business Barriers into Strengths," *Information Systems Management*, Fall, 2000.

# Electronic Commerce Strategy for Small and Medium Enterprises: Case Studies of Korean Firms

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## Abstract

Business firms are increasingly taking part in online business activities through internet as the size of the e-commerce market is rapidly growing in the recent years. Electronic commerce (EC) activities now become an essential part of the business strategy for survival as well as growth for both large enterprises and small- to medium-sized enterprises (SMEs).

Previous studies on e-commerce mostly focused on the adoption of EC by business firms, and also have been carried out with the data from big enterprises. More often than not, the results obtained from the large business firms are used to provide the guidelines for small to medium-sized enterprises (SMEs). SMEs are, however, different from large business firms in many aspects, and need to be studied on their own.

This paper extends the previous research on EC in two aspects. Firstly, we study the e-commerce issues in the area of implementation in relation to the business firm's performance, beyond the adoption and diffusion of IT technology which has been the research issues in many previous research. Secondly, we focus on small and medium enterprises which comprise a large portion of national economy with significant influence.

## 1. Introduction

Business firms are increasingly taking part in online business activities through internet as the size of the e-commerce market is rapidly growing in the recent years. Electronic commerce (EC) activities now become an essential part of the business strategy for survival as well as growth for both large enterprises and small- to medium-sized enterprises (SMEs). [1][4][7][8][9][11][12]

There has been a lack of empirical research on e-commerce, and those few previous studies on e-commerce mostly focused on the adoption of EC by business firms [3][5][6][10] such as identifying the factors for adopting e-commerce. Nowadays, it is inevitable to use EC in one way or another and the adoption of information technology is accepted as given for most business firms. It is then a time to decide which type of EC system to adopt and how effectively to use them.

Another drawback of previous research on EC is that they have been carried out with the data from big enterprises. More often than not, the results obtained from the large

business firms are used to provide the guidelines for small to medium-sized enterprises (SMEs) as if they are miniature big enterprises. SMEs are, however, different from large business firms in many aspects, and need to be studied on their own.

This paper extends the previous research on EC in two aspects. Firstly, we study the e-commerce issues in the area of implementation in relation to the business firm's performance, beyond the adoption and diffusion of IT technology which has been the main research issues in many previous research. For this purpose, we construct a theoretical model incorporating environmental factors, implementation variables, moderating variables, and the firm performance. Secondly, we focus on small and medium enterprises which comprise a large portion of national economy with significant influence.

## 2. Research Methodology

### 2.1 Research Model and Hypotheses

While previous studies focused on the adoption issues (Figure 1), this paper is to investigate the relationship between the factors and the variables that affect the adoption and implementation of the E-commerce by small and medium enterprises as shown in the research model (Figure 2). Table 1 contains the explanations for the variables, and the hypotheses that will be tested are as follows:

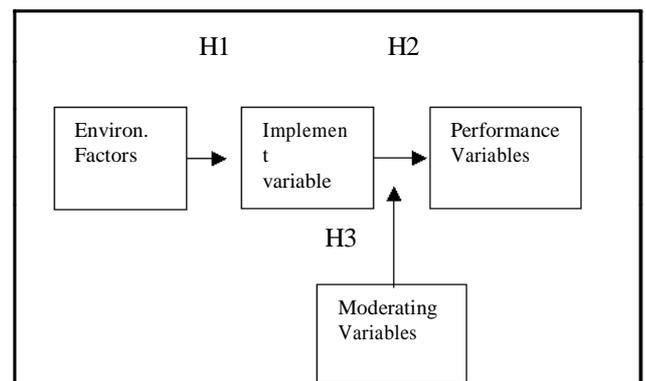


Figure 2. Research model for E-Commerce implementation.

**Hypothesis 1:** The firm's decision on which type of EC to implement is affected by the environment in which the firm operates.

The industry situation would affect a firm's decision when selecting the type of EC to adopt and implement. For example, those firms in such industries as logistics and

banking industry are more likely to use a Business-to-Consumer (B2C) type of E-Commerce system while manufacturing firms are more likely to adopt a Business-to-Business (B2B) type of EC system.

**Hypothesis 2:** The performance of a firm is affected by the type of EC which the firm implement.

A firm's performance is generally improved by adoption and implementation of electronic commerce. The magnitude of improvement, however, would be different by the type of EC system implemented by a firm.

**Hypothesis 3:** The impact of the EC type on the firm's performance would be affected by the moderating variables that show the general condition of the firm's information system such as IS intensity and maturity.

It is suggested that there is a time-lag before any IT system may produce substantial benefits for a firm. [2] Likewise, an EC system would need a lead time before it becomes an effective tool for improving the firm's performance.

**Table 1.** Explanation of the variables.

Variables	Contents
Environmental Factors	These are the environmental factors that affects a firm's adoption and implementation of the E-commerce such as the size of the and age of the firm, type of industry, competitive pressure, vertical relationship with other firms, environmental uncertainty.
Implementation Variables	These are the possible types of E-commerce that can be implemented by a firm such as: - B2B vs. B2C - Value chain vs. Industry type - Transactional, Strategic, or Informational types
Moderating Variables	These are the general condition of a firm's information system (IS) such as : - IS maturity - IS intensity
Performance Variables	These are the firm's performance in E-commerce area such as: - E-commerce (EC) utilization - EC satisfaction - EC usefulness

## 2.2 Data Collection and Analysis

For a preliminary test, we circulated questionnaires to 100 small and medium enterprises in Korea and 41 firms have returned the questionnaires. The data collected from the sample of 41 firms are used for analyses. Descriptive statistics are used for this conference paper and we will further use statistical methods such as analysis of variance (ANOVA) and regression to analyze the data for a final

version of the paper.

## 3. Preliminary Results

### 3.1 Business Environment and EC Implementation

The effect of the business environment on the firm's decision on EC implementation is measured. Two variables are selected to define the firm's business environment: the degree of competition facing the firm and the degree of information sharing with the suppliers and customers. Two dimensions of the firm's decisions are analyzed: the types of EC and the purpose of EC implementation. The types of EC for firm's selection include Business-to-Business (B2B), Business-to-Customer (B2C), and Business-to-Government (B2G). By the purpose, EC systems are classified into Transaction EC, Information EC, and Strategic EC.

The results from regression analysis show that a firm's decision on EC type selection is affected neither by the degree of competition nor by the degree of information sharing with the suppliers and customers, which are the partners in the firm's supply chain. Regardless of the degree of competition or information sharing, firms adopted fairly equally among the 3 types of EC. Also, the firm's purpose for implementing an EC does not seem to be affected by the business environment.

### 3.2 EC Implementation and EC Performance

We tested the relationship between the two implementation variables discussed above, EC type and EC purpose, and the EC performance experienced by the firm, utilization, satisfaction and usefulness. The average performance is compared between the groups of firms implementing the same type of EC and with the same purpose.

Among the EC types, those firms adopting B2C expressed the highest level of performance experience in all three measures of utilization, satisfaction and usefulness. The firms' experiences, however, are different between the implementation purposes. Information EC produced the best utilization and satisfaction for the firms, while Strategic EC provided the best usefulness for the firms.

### 3.3 IS Maturity and EC Performance

The impact of IS maturity, measured by the firm's knowledge and attention for the EC system, on the EC performance is examined. As portrayed in Figure 2, IS maturity is a moderating variable that plays an important role in understanding the relationship between the EC implementation and the firm's performance.

IS maturity is found to have a positive impact on the EC performance. As the level of firm's knowledge and attention for the EC system became higher, all three performance measures of utilization, satisfaction and usefulness increased. A higher level of knowledge and attention for the EC system can be achieved by a sustained investment in information technology by the firm over a long period of time. Therefore, a firm can improve its EC performance by

continued investment in IT system and resource.

## References

- [1] Blili, S. & Raymond, L. "Information Technology: Threats and Opportunities for Small and Medium-sized Enterprises," *International Journal of Information Management*, 1993, 13(6), 439-448.
- [2] Brynjolfsson, E. "The Productivity Paradox of Information Technology: Review and Assessment," *Communications of the ACM*, 1993, 35(12), 67-77.
- [3] Cragg, P. B. & King, M. "Small-Firm Computing: Motivators and Inhibitors," *MIS Quarterly*, 1993, 17(1), 47-60.
- [4] Doukidis, G. I., Smithson, S., & Lybereas, T. "Approaches to Computerization in Small Businesses in Greece," *Proceedings of the Thirteenth ICIS*, 1992, 139-148.
- [5] Fink, D. "Guidelines for the Successful Adoption of Information Technology in Small and Medium Enterprises," *International Journal of Information Management*, 1998, 18(4), 243-253.
- [6] Goode, S. & Stevens, K. "An Analysis of the Business Characteristics of Adopters and Non-Adopters of World Wide Web Technology," *Information Technology and Management*, 2000, 1, 129-154.
- [7] Igbaria, M., Zinatelli, N., & Cavaye, A. L. M. "Analysis of Information Technology Success in Small Firms in New Zealand," *International Journal of Information Management*, 1998, 18(2), 103-119.
- [8] Kettinger, W. J. & Hackbarth, G. "Selling in the Era of the Net: Integration of Electronic Commerce in Small Firms," *Proceedings of the Eighteenth ICIS*, 1997, 249-262.
- [9] Levy, M., Powell, P., & Galliers, R. "Assessing Information Systems Strategy Development Frameworks in SMEs," *Information & Management*, 1999, 36(5), 247-261.
- [10] Mehrtens, J., Cragg, P. B., & Mills, A. M. "A Model of Internet Adoption by SMEs," *Information & Management*, 2001, 39(3), 165-176.
- [11] Poon, S. "Business Environment and Internet Commerce Benefit - A Small Business Perspective," *European Journal of Information Systems*, 2000, (9), 72-81.
- [12] Thong, J. Y. L., Yap, C. S., & Raman, K. S. "Top Management Support, External Expertise and Information Systems Implementation in Small Businesses," *Information Systems Research*, 1996, 7(2), 248-267.

## Figures and Tables

Figures and tables are available upon request.

# The Comparison in Cognition on Outsourcing Decision for Accounting and Taxation between Cross Straits

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## Abstract

By inquiring both companies between the Taiwan and Mainland China, the purposes of this study are (1) to specify the contents of accounting and taxation activities will be outsourced, (2) to identify which segment is suit for outsourcing and what are the odds, (3) to compare the attitude toward the taxation agent systems, and (4) to know whom will be eligible for serve in the accounting and tax service.

Following main findings are reached through this study. First, the companies in Taiwan do not conceive such kinds of activities, which on cash flow and budget matters could be outsourcing from outside while those of Mainland China do. However, such activities like tax closing entries and tax calculation are considerable to be outsourced in Taiwan. Second, both companies concur that parts of the organization functions should be outsourced. Furthermore, there exists significant difference on information disclosure and independence of outsourcee (external service providers) among the merits and demerits of outsourcing. The Mainland Chinese companies think that outsourcee may loss its independence on account of outsourcing. Third, both companies have consistently cognition on the system of professional accounting and taxation agent. Finally, the one who is a CPA, a tax expertise, or a tax practitioner will be qualified to take on such responsibilities.

Keywords : Outsourcing, CPA, Tax Practitioner, Tax Expertise , Disintermediation

## 1. Introduction

The practice of outsourcing has been a logical alternative for non-strategic areas such as payroll processing, public relations, building maintenance, and human resources. Recently, outsourcing has become a more visible perception as companies turn to it in operational areas, such as engineering, logistics, design, and tax. Firms are regularly outsourcing their accounting and tax function to CPA (Certified Public Accountant) firms or tax accountant firms (Tax practitioner), as well as to niche firms that specialize in the service. According to research compiled by G-2 Research Inc. [31], the percentage of U.S. corporation's tax compliance costs spent with outsourcers has quintupled from about 3 percent in 1992 to 15 percent in 1996. In the vertical integration and transaction cost economics respects, Alexander and Young [1] conducted that outsourcing is worthy of special

attention only of changes in current attitudes and practices could unlock significant latent or unrealized value.

On the other hand, a survey of the Ministry of Economic Affairs [50] reported that near 80% of companies in Taiwan are outsourcing their accounting or tax related matters from professional agents, including CPA firms and tax declaration agents, to save costs for the past few decades. Meanwhile, since 1994, Value-Added Tax (VAT) was reformed in Mainland China and contributed more than 40% of the government revenue [51]. Not only are they saving more costs, but also they are facilitating the focus of their tax and accounting practices to be more proactive.

The systems of accounting and tax between Taiwan and Mainland China are different, however, the cognition on outsourcing decision is homologous. For example, the purpose of tax declaration agent system in Taiwan is to help taxpayers to file tax return properly, and, the main function of VAT in Mainland China is to help government to moderate tax evasion problem. On the other hand, both the agents of accounting firm and tax firm in Mainland China must pass professional examination before they serve such kind of services. In Taiwan, however, only the CPA does. Because the system of tax accountant is not legislating yet, tax firms offer such kind of services through lore and experience. Thus, the services of Tax practitioner are subject to booking and a wide variety of tax services, but no auditing work.

To learn more about the perception of the accounting and tax function, the compatibility of outsourcing, the merits and demerits of outsourcing, the role of tax accountant, and the precedence of intermediary, this paper conducts a survey of senior officers both at small and medium-sized companies of cross strait.

There is a minimum level of business required for outsourcing. Factors such as minimum processing costs, current active business, and projected growth are considered in the outsourcing equation. Along with the extension of IT, would such kind of services be negligent under the e-business environment? Does e-business in taxation service system may replace the traditional role of Tax practitioner? This paper is the second of two articles reporting the results of that survey. The first article was presented at The 2002 Cross-Strait Conference on Finance, Economics and Business, Taipei in April 2002 and focused on views of companies and professional

firms in Taiwan. This article addresses the comparison in cognition on outsourcing decision between the cross straits.

## 2. Views of Accounting and Tax Outsourcing

In the past, a company hired outside expertise such as legal services for a specialized purpose, but did not shift wholesale responsibility for its accounting needs to another entity.

There is wider recognition of outsourcing as a tool for day-to-day management. Outsource services CPA firms provide most often are accounting and finance functions, payroll, accounts receivable/payable, financial statement preparation and analysis, budgeting, cash management, internal audit and tax.

Since the mid-1980s, Taiwan has launched two important tax reforms: one was the change of sales tax from the multiple-stage gross business receipts tax (GBRT) to the value-added tax (VAT) in 1986; the other was the establishment of the integrated system since 1998. The VAT has served as an effective remedy for resolving the problem of double taxation in sales tax. Similarly, the integrated system is the only way to mitigate double taxation on dividend income. Both systems discard multiple or double taxation and both are consisted with different stages of economic development.

Hereupon, the purpose of tax declaration agent system is to help taxpayers to file tax return properly. However, the existence of this system and its function has been debated for the last few decades. People argue the quality of financial statement the Tax practitioner made, doubt the ability of tax declaration agent, and require tax declaration agents to get license before they are qualified for this job.

In recent years, companies have looked primarily to technological improvements to cut expenses. While companies continuously seek creative methods to improve efficiency, handling both tax and accounting bills and payments can be a costly headache for companies. Thus, outsourcing these functions may offer many benefits. Johnson [21] stated that tax service is at the forefront of outsourcing because of the market is competitive and fees have continued to stay low over the years.

Most companies have traditionally outsourced a variety of tax functions, including international and expatriate tax administration, executive tax preparation services, relocation tax administration, acquisition and merger tax, investment tax credits, reverse sales audits, and property tax billing.

Before the emergence of the Internet and the Web, practitioners generally found the most reliable and most easily accessible source of tax information in tax services or in tax journals published by reputable organizations.

For most large companies the primary reason to outsource may reduce costs<sup>1</sup> and for some companies the main motivation may be to gain access to greater expertise or to be able to focus on core activities. For companies, five principal reasons to outsource are to: (1) reduce and control operating costs, (2) improve company focus, (3) gain access to world-class capabilities, (4) free internal resources for other purposes, and (5) obtain resources that are not available internally [5]. On the other hand, companies that outsource often experience one or more of the following drawbacks. There are: inflexibility, loss of control, reduced competitive advantage, locked-in system, unfulfilled goals, and poor service [29].

In early 1990s, Levine and Lerner [22] described how the tax executive might better approach the issue of outsourcing to do a more effective job of managing the tax function of the company. After having digested the accounting firm's responses to an outsourcing survey, Moore [23] concluded that accounting firms are becoming more aggressive in pursuing outsourcing until proven otherwise. Tax professionals in private industry are willing to change, adept, streamline, and automate.

The 1990s were the decade of integrated software, with software suites playing a prominent role. Crampton and Graig [10] compared Microsoft's Office Professional with the competing products from Lotus and Borland in terms of included applications, system requirements, and retail prices. Gellis [18] and Bradbury [6], as well as Yakal [34], also introduced computer software for Windows and for Macintosh respectively for tax accountants. Furthermore, Hawaleshka [19] reported on two Canadian companies offering services for doing income taxes online. It seems that a tax practitioner or an accountant may attempt to access pertinent information quickly from the Web as a free source. However, after trying hundreds of hours, Sumutka and Chang [32] concluded that it is not that easy and in many cases the information is not that useful either. They asserted that the Web does not change the fact because none of these sources are available on the Web free of charge. The problems encountered by tax accountants in accessing information from the Web are its accuracy, degree of sophistication, and accessibility (i.e., its usefulness).

Determining if clients are the right cultural match for each other and establishing a clear understanding of the engagement specifications at the outset are the key to making outsourcing work [5].

Based on strategic outsourcing theory, the transaction-cost motivations have been studied in a variety of settings. For examples, Dunbar and Phillips [15] indicate that transaction costs relating to human-asset specificity, proprietary technology, and economies of

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<sup>1</sup> For example, Berson (2001) stated that most large, for-profit organizations outsource their accounting, and it can cut them by 25% to 50%.

scale, along with the status of firm's top tax professionals and recent growth, are factors that affect the tax function outsourcing decision. This paper extends this investigation to a knowledge-based professional services setting in which external tax professionals have opportunities to serve tax and accounting knowledge that increase firm value.

A general economic trend in corporate tax function outsourcing has been viewed with concern. In a study more closely related to mine, Dunbar and Phillips [15] provides the first evidence of the standpoints associated with tax and accounting function outsourcing between the cross straits. Dunbar and Phillips [15] investigated the factors associated with firms' decisions to outsource corporate tax-planning and –compliance activities.

### 3. Methodology

This study employs survey research to investigate small and medium-sized enterprises in Mainland China and Taiwan. The outsourcing questionnaire consisted of 80 questions covering many areas of concern common to the private industry tax community. Information for this study was obtained through a questionnaire mailed in November 2000 to 317 senior tax administrators of companies. There were 171 responses to the request. The overall response rate was 53.94 Percent. A broad cross-section of companies responded to the survey.

The survey includes general instructions and questions relevant to constructing the survey-related variables. Questionnaires were sent to corporate executives at random. Survey instruments were sent to 317 firms totally. Of which 217 copies were sent to Taiwan and the others were sent to Mainland China. In Taiwan, three or Four weeks after the initial mailing, non-respondents were sent Fax or call reminders. Thereafter, non-respondents were sent second reminders along with the questionnaire. After removing unavailable or blank data from the sample, this process yielded 160 survey responses, resulting in a response rate of 73 percent. Neither however, suffer for economy, neither Fax nor second reminders were sent for non-respondents in Mainland China. Many responders felt the questions were "hard," "tough," "copious," etc. This process yielded only 14 survey responses, resulting in a response rate of 11 percent after filtering out 3 percent of nullity.

### 4. The Main Findings

The findings of the preliminary and principal studies comprise many different facets.

Table 1 presents descriptive statistics that compare Taiwanese firms to Mainland China firms at fundamental items. The comparative statistics presented indicate that Taiwanese firms are longer, larger, more variety at industry and human resource. The survey do not targeted

larger firms with a tax executive to ensure a response rate adequate to produce a sample large enough to test any hypotheses. Accordingly, it is not clear whether the results generalize to larger publicly traded firms.

Insert Table 1 here.

Insert Table 2 here.

The comparative statistics presented in Table 2 reveal the ways of declaration, bookkeeping, tax-announcement between Taiwanese firms and Mainland China firms. Most of the firms respond that firms do bookkeeping and tax-announcement by themselves or their accountant. Many of the companies do tax related works via the assistance of accounting professional service firms.

Insert Table 3 here.

Table 3 presents the descriptive statistics and t-Test of difference in means on the contents of accounting and taxation activities will be outsourced. At the "cash budget" item, the means for Taiwanese firms and Mainland China firms are 2.238 and 2.9, respectively; indicate that the perceptions of cash budget made to external service providers differ rather. Moreover, at the "budget management" item, the Taiwanese firms are reluctant to outsource while the Mainland China firms are neutral. In addition, the means for "tax calculation" item are 3.453 and 2.6 respectively, indicate that Mainland China firms are quite object to let this matter be outsourced. Both at the "tax closing entries" and "preparing annual income tax return" items, the Mainland China firms relict at budgets providing by outsiders. Taken altogether, the Mainland China firms do not conceive such kinds of activities, which on "tax calculation," "tax closing entries," and "preparing annual income tax return" could be staffed from outsider while those of Taiwanese do. However, such activities like "budget matters" are not considerable to be outsourced in Taiwan.

Insert Table 4 here.

Companies typically maintain those things that differentiate them from their competitors and provide a true competitive advantage. How do the firms determine what to outsource? Table 4 presents the result about what segments of organization to outsource. Outsourcing part of corporate departments is probably the solution for most of the companies that currently have accounting/tax departments. For most sample companies, core functions include internal auditing and payroll, of which functions choose to outsource eventually. The first segments for Mainland China Firms to outsource are part of operating functions and Administrative functions. Similarly, the first two choices for Taiwanese firms are Tax and part of operating functions. That is to say, with the growing trend toward focusing on core business capabilities, both the companies are outsourcing selected business functions to outside expert partners who can perform them more efficiently and cost-effectively.

Insert Table 5 here.

The results of the conception among merits and demerits of outsourcing are reported in Table 5.

There exists significant difference on information disclosure and independence of outsourcee among the merits and demerits of outsourcing. The Mainland Chinese companies think that outsourcee may lose its independence on account of outsourcing. However, the Taiwanese companies admit outsourcing of solution and of transparency. But, the Taiwanese companies do not assume that external service providers may lose its independence.

About the potential for loss of control of outsourced processes, both the companies do not think that they will be lost of costs management, nor shrinking organization or worse communication. In fact, many of the companies take the matter that there are a number of controls to maintain and enhance the management of the accounting and tax functions through outsourcing.

Taken altogether, both Mainland China and Taiwan companies seem agree at the merits but demerits. The first two advantages management seeks from outsourcing are: reduce and control operating costs and improve company focus. In a tight market, expense control is more important than ever. But today, as clients demand increased value and security requirements escalate, cost saving seems unachievable. Most will uncover the obvious - reengineer antiquated systems, automate manual processes, consolidate systems, launch a new methodology, and the list goes on.

Insert Table 6 here.

The t-Test results of difference on comparing the attitude toward the taxation agent systems are presented on Table 6. Both companies have consistently cognition on the system of professional accounting and taxation agent. Moreover, the Taiwanese companies show more positive attitude than Mainland China companies. Particularly, at the items of "Insuring firm's processing criteria" and "Reducing operating expense," the Taiwanese companies are significantly assenting.

Insert Table 7 here.

Though accounting and tax outsourcing start as an outgrowth of cost-cutting initiatives, today, the industry is looking into strategic alliance. Accounting and tax outsourcing is a decision a lender should approach with definable objectives and measurable results. From the result of Table 7, it indicates that a CPA, a tax expertise, or a tax practitioner will be qualified to take on such responsibilities. The company who can complement its accounting and tax capabilities in consulting, systems integration and outsourcing will be eligible to form business alliance with company.

## 5. Conclusion

This research provides the first evidence of the

standpoints associated with tax and accounting functions outsourcing between the cross straits. Regardless of the company being downsized, reengineered, or overcapacity, the most common reason cited for outsourcing a portion or all of the accounting and tax functions was financial savings. Besides, there are technological changes being made in the industry that have significantly streamlined processes and reduced manual efforts commonly associated with the business. In this study, both of the companies do not fear for losing competitive advantage.

On the other hand, tax service companies are facing new challenges and creating new ways to perform traditional services. With regard to the continuous outsourcing accounting and taxation, when international accounting and taxation are complex, task difficult, and change of requirements frequent, facilities and human resources can be substituted by contractors to reduce risk and to increase flexibility. The practice of tax or accounting outsourcing is not new and is reviewed as an outgrowth of cost-cutting initiatives; today companies are looking beyond cost cutting and into strategic alliances.

## Reference

- [1] Alexander, M., and D. Young, Outsourcing: Where's the Value? Long Range Planning, 1996, Vol. 29, No. 5, 728-730.
- [2] Arlinghaus, B. P., Tax Department Trends: Organization, Outsourcing, and the Use of Consultants, Tax Executive, Jan/Feb99, Vol. 51 Issue 1, 29-35
- [3] Aubert, B. A., S. Rivard and M. Party, A Transaction Cost Approach to Outsourcing Behavior: Some Empirical Evidence, Information & Management, 1996, Vol. 30, 51-64.
- [4] Ayres, F. L., B. R. Jackson, and P. A. Hite, "The economic benefits of regulation: Evidence from professional tax preparers." The Accounting Review, 1994, 64 (2): 300-312.
- [5] Berson, W., How to Built an Outsourcing Niche, Journal of Accountancy, Nov. 2001, Vol. 192, No. 5, 47-51
- [6] Bradbury, J., Tax-Preparation Software, Macworld, 2002, March, 55-56
- [7] Bryce, D., and M. Useem, The Impact of Corporate Outsourcing on Company Value, European Management Journal, 1998, Vol. 16, No. 6, 635-643.
- [8] Cassius, G. M., Tax Outsourcing, Mortgage Banking, Dec96, Vol. 57 Issue 3, 77-84,
- [9] Cloyd, C. B., "The effects of financial accounting conformity on recommendations of tax preparers." The Journal of the American Taxation Association, 1995, 17 (2): 50-70.
- [10] Crampton, W. J. and Graig, C.K., Integrated Packages are a New Tool for Tax Accountants, Taxation for Accountants, October 1994., Vol. 53, No. 4, 249-252
- [11] Cuccia, A. D., "The effects of increased sanctions on paid preparers: Integrating economic and psychological factors." The Journal of the American Taxation

- Association, 1994, 16 (1): 41-66.
- [12] Cuccia, A. D., K. Hackenbrack, and M. W. Nelson, "The ability of professional standards to mitigate aggressive reporting." *The Accounting Review*, 1995, 70 (2): 227-248.
- [13] Cunningham, S., *Outsourcing: the Key to Adding Value*, *International Tax Review*, Jun2001, Vol. 12 Issue 6, p13-17.
- [14] Deloitte & Touche 編, *委外業務導入之場所*, 1999, 日本中央經濟社.
- [15] Dunbar, A. E. and Phillips, J. D., *The Outsourcing of Corporate Tax Function Activities*, *Journal of the American Taxation Association*, Fall2001, Vol. 23 Issue 2, 35-49
- [16] Duncan, W. A., D. W. LaRue, and P. M. J. Reckers, "An empirical examination of the influence of selected economic and noneconomic variables in decision making by tax professionals." *Advances in Taxation*, 1989, 2: 91-106.
- [17] Ericsson, and J. Smith, eds., *"Toward a General Theory of Expertise."* New York, NY: Cambridge University Press, 1991.
- [18] Gellis, H. C., *WisRule for Windows Revolutionizes database management*, *Taxation for Accountants*, May, 1995, Vol. 54, No. 5, 313-315
- [19] Hawaleshka, D., *Doing Your Taxes on the Web*, *Maclean's*, 2/25/2002, Vol. 115, Issue 8, 33-34
- [20] Holub, S. F., *The New Face of Tax Outsourcing*, *Tax Adviser*, Mar2002, Vol. 33 Issue 3, 198-200
- [21] Johnson, M. R., *Deep in the Heart of Taxes*, *Mortgage Banking*, Feb2000, Vol. 60 Issue 5, 75-77
- [22] Levine, M. A.; Lerner, H. J., *Outsourcing: Opportunities and Challenges for the Corporate Tax Executive*, *Tax Executive*, Sep/Oct93, Vol. 45 Issue 5, 375-381
- [23] Moore, S., *Outsourcing the Tax Function: A Survey*, *Tax Executive*, May/Jun 1994, Vol. 46 Issue 3, 175-186.
- [24] Morris, A. and James, T., *Could Outsourcing Help? Management Accounting: Magazine for Chartered Management Accountants*, Nov99, Vol. 77 Issue 10, 44-45
- [25] Mougayar, W., *Opening Digital Markets - Battle Plans and Business Strategies for Internet Commerce*, McGraw Hill. 2000.
- [26] Ray M. Sommerfeld; Hershel M. Anderson; Horace R. Brock; James H. Boyd. Silvia A. Madeo & G. Fred Streuling, *An Introduction To Taxation*, Harcourt Brace Tovanovich, Publishers, 1988.
- [27] Reckers, P. M. J., D. L. Sanders, and R. W. Wyndelts, "An empirical investigation of factors influencing tax practitioner compliance." *The Journal of the American Taxation Association*, 1991, 13 (2), 30-46.
- [28] Roberts, M. L., "Tax accountants' Judgment/Decision-Making research: A review and synthesis." *The Journal of the American Taxation Association*, 1998, 20 (1), 78-121.
- [29] Romney, Marshall. B. and Steinbart, Paul John, *Accounting Information System*, ninth edition, Prentice Hall, 2003,.
- [30] Schisler, D. L., "An experimental examination of factors affecting tax preparers' aggressiveness —A prospect theory approach." *The Journal of the American Taxation Association*, 1994, 16 (2): 124-142.
- [31] Springsteel, I., *External Revenue Service, CFO*, Oct97, Vol. 13 Issue 10, 101-104
- [32] Sumutka, A. R. and Chang, T. C., *Is the Internet Overhyped as Useful Source for Tax Practitioners? Taxation for Accountants*, February 1997,., Vol. 58, Issue 2, 68-77
- [33] Vining, A. and S. Globerman, *A Conceptual Framework for Understanding the Outsourcing Decision*, *European Management Journal*, 1999, Vol. 1, No. 6, 645-654.
- [34] Yakal, K., *Tax Software 2001 Style: Better, Smarter*, *PC Magazine*, 01/29/2002, Vol. 21, Issue 2, 24-26
- [35] 吳崇文, *組織差異、資訊功能特性與互信對委外任務成效的影響*, 中央大學資訊管理研究所未出版碩士論文, 1998。
- [36] 呂仁琦, *我國營利事業所得稅擴大書面審核制度之研究—台灣省北區廠商實證研究*, 中原大學會計學系出版碩士論文, 2000。
- [37] 李永山, *台灣中小型企業對資訊作業委外決策之研究*, 臺灣大學商學研究所未出版博士論文, 1999。
- [38] 林玉華, *電子商務應用於稅務代理業之研究*, 大葉大學工業工程研究所未出版碩士論文, 2000。
- [39] 徐綺憶, *資訊系統委外程度與績效之影響因素：一個二階層的實徵性研究*, 中央大學資訊管理研究所未出版博士論文, 1998。
- [40] 馬秀如, *「商業、會計、記帳人—記帳業與會計師相爭的三方演義」*, *會計研究月刊*, 1998, 第156期, 18-28。
- [41] 張永揚, *報稅代理制度的建立對我國租稅稽徵影響之研究*, 中華大學工業工程與管理研究所未出版碩士論文, 1999。
- [42] 張明德、王金和, *電子商務交易所得稅課稅權之探討(上)(下)*, *中國稅務旬刊*, 2000, 第1759-60期, 12-17; 16-20。
- [43] 張清課, *營利事業所得稅申報與查核方式之研究-台灣省中部地區廠商實證分析*, 朝陽大學財務金融研究所未出版碩士論文, 1998。
- [44] 張雅如, *作業基礎成本制度之設計及交易成本理論之應用--以個案公司為例*, 東吳大學會計學系未出版碩士論文, 1998。
- [45] 許良雄, *我國會計師稅務簽證制度之研究*, 中華大學工業研究所未出版碩士論文, 1996。
- [46] 許德進, *醫療資訊系統外包作業之研究*, 中國醫藥學院醫務管理研究所未出版碩士論文, 1998。
- [47] 黃仁伯, *資訊系統委外環境與類型之探討*, 交通大學經營管理研究所未出版博士論文, 1999。
- [48] 楊美圓, *我國報稅代理人制度建制爭議之探討*, 國立交通大學經營管理研究所未出版碩士論文, 1999。
- [49] 楊竣仁, *會計師與記帳業者處理稅務異同之探討*, 中正大學會計學研究所未出版碩士論文, 1999。
- [50] 經濟部, *90年中小企業白皮書*, 2001, <http://www.moeasmea.gov.tw/html/90white/white%2Ehtm>
- [51] 蔡素貞, *中國大陸增值稅逃漏現狀之探討*, 淡江大學大陸研究所未出版碩士論文, 1999。
- [52] 戴基峰, *影響軟體系統委外滿意度因素之研究：從交易成本與社會關係探討*, 中央大學資訊管理研究所未出版碩士論文, 1996。

Table 1 : Comparative Firm Characteristics

Percent Contents	Characteristics	Taiwanese firms	Mainland China firms
Organization	Proprietorship	13.75%	36.36%
	Partnership	23.13%	9.09%
	Company	52.50%	54.55%
	Other (Public Services)	10.62%	
Industry	Manufacturing	20.89%	27.27%
	Retails	9.49%	
	Services	47.47%	18.18%
	Hard Ware Industry	4.43%	
	Soft Ware Industry	3.16%	9.09%
	Clinic	0.00%	9.09%
	Banking and Finance	5.70%	
	Other Industry	8.86%	36.36%
Set up Year	Under 1 year	3.80%	9.09%
	1 ~ 2 years	2.53%	9.09%
	3 ~ 5 years	12.03%	36.36%
	6 ~ 10 years	26.58%	45.45%
	11 ~ 20 years	31.01%	
	21 ~ 40 years	18.99%	
	41 ~ 70 years	3.80%	
	71 years beyond	1.27%	
Capital	Under 5 Million	33.57%	36.36%
	5.01 ~ 10 Million	15.38%	
	10.01 ~ 20 Million	5.59%	
	20.01 ~ 30 Million	6.99%	18.18%
	30.01 ~ 60 Million	4.20%	27.27%
	60.01 ~ 100 Million	4.20%	9.09%
	100.01 ~ 300 Million	8.39%	
	300.01 ~ 1000 Million	9.09%	9.09%
	1.01 Billion over	12.59%	
The annual amount of its business operations for last consecutive year	Under 5 Million	18.71%	
	5.01 ~ 30 Million	29.03%	18.18%
	30.01 ~ 100 Million	14.84%	54.55%
	100.01 ~ 500 Million	13.55%	27.27%
	500.01 ~ 2000 Million	7.74%	
	2.01 ~ 5 Billion	9.03%	
	5.01 Billion Over	6.45%	
Full-timer personnel	Under 10 persons	33.75%	9.09%
	11 ~ 30 persons	15.63%	9.09%
	31 ~ 60 persons	11.25%	18.18%
	61 ~ 100 persons	5.00%	9.09%
	101 ~ 500 persons	17.50%	45.45%
	501 ~ 1,000 persons	14.38%	9.09%
	1,000 persons Over	2.50%	
Personnel at Accounting and Tax Section	None	6.96%	
	1 ~ 5 persons	55.70%	63.64%
	6 ~ 10 persons	15.82%	27.27%
	11 ~ 20 persons	11.39%	
	21 ~ 40 persons	7.59%	9.09%
	41 ~ 60 persons	0.63%	
	61 ~ 100 persons	0.63%	

	101 persons Over	1.27%	
Seniority	Under 1 year	8.13%	9.09%
	1~2 years	18.75%	9.09%
	3~5 years	28.75%	36.36%
	6~10 years	20.00%	45.45%
	11 ~ 15 years	14.38%	
	16 ~ 20 years	8.13%	
	21 ~ 30 years	1.25%	
	31 years Over	0.63%	

Note: The exchange rate for one RMB to NTD is about 1 for 4.3.

Table 2 : Comparative for Declaration for Tax payment

Contents	Percent	Characteristics	Taiwanese firms		Mainland China firms	
			Mean	Std. Dev.	Mean	Std. Dev.
Declaration for tax payment		Use the Extant Expended Paper Review	7.50%		27.27%	
		After duly audited and certified by a certified public accountant	25.00%		9.09%	
		Use the blue colored tax returns	3.13%			
		Assisted by a CPA	45.00%		27.27%	
		Assisted by a Tax practitioner	7.50%		9.09%	
		Via magnetic tapes or disks (the media)	11.88%		9.09%	
		Not Known	3.13%		18.18%	
		Other	6.26%			
Whom in Charge at bookkeeping or accounting		Owner-self	21.25%		18.18%	
		Accountant	46.25%		36.36%	
		Tax practitioner	17.50%		18.18%	
		CPA	8.13%		18.18%	
		Software officer	1.25%		9.09%	
Whom in Charge at tax-announcement		Accountant	21.25%		72.73%	
		Tax practitioner	21.25%		18.18%	
		CPA	51.88%		9.09%	
		Software officer			0.00%	

Table 3: t-Test Results of Difference in Means on the contents of accounting and taxation activities will be outsourced

Items No.	Contents	Taiwanese firms		Mainland China firms		t-Test p-value	Significance
		Mean	Std. Dev.	Mean	Std. Dev.		
1	Recording account books and documents of evidence	2.913	1.178	2.3	0.823	0.1078	
2	Preparing vouchers	2.875	1.191	2.7	0.949	0.6495	
3	Recording and posting	2.95	1.212	2.889	1.167	0.883	
4	Daily accounting transactions	3.388	1.138	3.3	1.059	0.8132	
5	Cash deposit management	2.113	0.871	1.8	0.789	0.2695	
6	Cash receiving/collecting management	2.163	0.91	2.0	0.667	0.5799	
7	Cash paying	2.2	0.923	1.8	0.632	0.1794	
8	Cash budget	2.238	0.961	2.9	1.287	0.0399	**
9	Money management	2.194	0.921	2.2	0.789	0.9833	
10	Finance consultation	3.294	1.163	3.7	0.949	0.2812	
11	Preparing financial statements	3.069	1.25	3.5	0.972	0.2861	
12	Preparing in-house management reports	2.629	1.117	2.7	0.823	0.8436	
13	Closing account	2.73	1.135	2.8	1.033	0.8485	
14	Tax closing entries	3.208	1.097	2.6	1.265	0.0941	*

15	Preparing closing leaves/annual income return declaring	3.233	1.109	3.0	0.816	0.5156	
16	Tax calculation	3.453	1.095	2.6	1.075	0.0179	**
17	Preparing annual income tax return	3.444	1.109	2.778	1.093	0.0812	*
18	Bookkeeping consultation	3.569	1.062	3.4	0.843	0.623	
19	Segments of accounting books	2.894	1.13	3.0	0.943	0.7716	
20	Budget management	2.663	1.11	3.3	0.823	0.0762	*
21	Daily business processes	2.625	1.148	3.1	0.994	0.203	
22	Other account books management	3.356	1.151	3.1	0.876	0.4907	
23	Computerized accounting system	3.4	1.111	3.2	0.919	0.5784	
24	Computerized tax system	3.538	1.051	3.1	1.101	0.2047	
25	Tax declaration and consultation	3.725	0.984	3.7	1.160	0.9386	

Note: \*, \*\*, and \*\*\* denote significance at the 0.1, 0.05, and 0.01 levels, respectively.

Table 4: t-Test Results of Difference in Means on suit for outsourcing segment

Items No.	Functions	Taiwanese firms		Mainland China firms		t-Test p-value	significance
		Mean	Std. Dev.	Mean	Std. Dev.		
1	Parts of operating functions	3.7	0.91	3.909	0.302	0.4498	
2	IT function	3.444	1.032	3	0.894	0.1666	
3	Internal auditing functions	2.888	1.138	2.727	0.905	0.6485	
4	General Ledger functions	2.938	1.158	2.545	0.82	0.272	
5	Payroll functions	2.631	1.114	2.909	0.944	0.4208	
6	Administrative functions	3.588	0.987	3.909	0.539	0.287	
7	Tax functions	3.75	0.932	3	1	0.011	**

Note: \*, \*\*, and \*\*\* denote significance at the 0.1, 0.05, and 0.01 levels, respectively.

Table 5: t-Test Results of Difference in Means on among the merits and demerits of outsourcing

items No.	Merits and Demerits	Taiwanese firms		Mainland China firms		t-Test p-value	significance
		Mean	Std. Dev.	Mean	Std. Dev.		
1	Cost savings	3.85	0.841	3.545	0.688	0.2422	
2	Achieve operational excellence	3.688	0.892	3.455	0.688	0.3973	
3	Possess competition to market	3.713	0.9	3.364	0.505	0.2059	
4	Flexibility and respond quickly	3.756	0.822	3.364	0.674	0.1237	
5	In company focus	3.863	0.82	3.545	0.688	0.2126	
6	Transparent performance	3.719	0.818	3.182	0.874	0.0374	**
7	Transparent disclosure	3.725	0.816	3.091	0.831	0.0137	**
8	Improve firm's value	3.531	0.911	3.091	0.831	0.1208	
9	Loss of in-house knowledge	2.894	0.922	2.455	0.688	0.1234	
10	Lost of tactics integration	2.75	0.854	2.636	0.924	0.6716	
11	Reduced competitiveness	2.475	0.808	2.091	0.539	0.123	
12	Demoralizing/falling employees' morale	2.538	0.831	2.182	0.603	0.1655	
13	Leaking classified information	2.919	0.984	3.364	0.674	0.1424	
14	Changing business processes	3.25	0.925	3.182	0.751	0.8114	
15	Lost of costs management	2.644	0.907	2.455	0.688	0.4986	
16	Shrinking organization	2.65	0.926	2.455	0.82	0.4966	
17	Worse communication	2.606	0.905	2.909	1.044	0.2892	
18	Contractor become bloated organization	2.831	0.933	2.455	0.82	0.194	

19	Contractor will be over invested	3.057	0.859	3.3	0.675	0.3809	
20	Disengagement result in contractor lost customers	2.912	0.889	2.7	0.675	0.4603	
21	Contractor will be lost of independence	2.824	0.831	3.4	0.699	0.0335	**

Note: \*, \*\*, and \*\*\* denote significance at the 0.1, 0.05, and 0.01 levels, respectively.

**Table 6: t-Test Results of Difference in Means on comparing the attitude toward the taxation agent systems**

items No.	Contents	Taiwanese firms		Mainland China firms		t-Test p-value	significance
		Mean	Std. Dev.	Mean	Std. Dev.		
1	Simplifying tax processing	4.25	3.243	4.091	0.539	0.8714	
2	Enhancing the efficiency of collection authority	3.969	0.73	4.091	0.539	0.5872	
3	Insuring firm's processing criteria	3.769	0.892	3.273	1.104	0.0807	*
4	Improving firm's accounting systems	3.656	0.945	3.6	0.843	0.8546	
5	The tax market will be withered in that media effect	3.156	0.894	3	0.775	0.5729	
6	Reducing operating expense	3.686	0.865	3.182	0.751	0.0617	*
7	Not keeping the bookkeeping peace	3.101	1.086	3.1	0.568	0.9986	
8	Losing voucher or manipulating data	3	1.108	2.8	0.919	0.5774	
9	Delinquently income return declaring	2.786	1.046	2.6	0.843	0.5821	
10	Error or inconformity on cash account	3.208	1.038	2.8	0.422	0.2194	
11	Error or inconformity on account balance	3.069	1.032	3	0.667	0.8347	
12	Leaking classified information	2.981	1.064	2.7	0.823	0.4138	
13	Lack of other accounting information	3.119	1.09	2.8	0.632	0.3621	
14	Lack of other managerial information	3.15	1.1	2.9	0.568	0.4779	
15	Lost of internal control function	3.031	1.072	2.9	0.876	0.7053	

Note: \*, \*\*, and \*\*\* denote significance at the 0.1, 0.05, and 0.01 levels, respectively.

**Table 7: Who will be eligible for serve in the accounting and tax service**

candidate	Firm; score	Taiwanese firms		Mainland China firms	
	score	Ordinal	score	Ordinal	
1. Who realize business processes	68		4		
2. Who know a system with substance and costs	28				
3. Who understand outsourcer's operational objectives	75		7		
4. Who is a software maker	10		0		
5. Who commission a tax agent for annual income tax	43		0		
6. Who prepare annual income tax return himself	14		0		
7. Who incorporate with tax agent	46		3		
8. Who well communicate with outsourcer	107	4	9		
9. Who align himself with outsourcer	13		10	4	
10. Tax agent	166	2	13	1	
11. CPA	257	1	11	2	
12. Tax practitioner	123	3	11	2	

# Adaptive Strategies of Firms in High-Velocity Environments: The Case of B2B Electronic Marketplaces

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## Abstract

Electronic marketplaces operate in highly dynamic environments. B2B (Business-to-business) e-Commerce (Electronic Commerce) is expanding rapidly, but Independent Internet based Electronic Marketplaces (IBEM) have passed through periods of boom and bust. In start-up entrepreneurial ventures such as IBEMs, adaptation is critical than at any other stage in the life cycle and hence the ability to learn and adapt becomes a key competency. The research uses the resource-based theory as a means of analyzing the evolution and adaptation of the resources and capabilities of IBEMs and the sustainability of competitive advantage. We use four case studies to trace the pattern of adaptation as well as identify the variables. Based on the inputs from this, we use a comprehensive sample of 135 IBEMs across various geographic regions covering 15 industry segments. The findings of this study provide key managerial insights into various issues that are important to IBEMs in particular and start-up entrepreneurial firms operating in highly dynamic environments in general. These include the stages of evolution and the sources or the lack of competitive advantage at each stage, the type of resources and capabilities, which need to be built, the type of complementary assets, which needs to be leveraged and the degrees of adaptation at various stages.

## 1. Introduction

The Internet is transforming the nature of interorganizational commerce by enabling various types of business-to-business (B2B) transactions. Internet is also having a major impact on the roles of markets [39] [40]. By reducing the search costs of buyers it is facilitating price competition among sellers Bakos [41] [42]. Independent Business to business Internet based Electronic Marketplaces (IBEMs) leverage Internet technologies and standards to distribute product data and to facilitate online-transactions. IBEMs have undergone rapid changes in terms of their market valuations, customers, lines of businesses, mode of service/product delivery, distribution channels as well as their alliances. In high-velocity environments, changes in demand, competition and technology are rapid and information is inaccurate, unavailable or obsolete. IBEMs operate in an industry characterized by all the above factors. From 1998 to 2000, B2B eCommerce grew more than 1000%, and by the second quarter of 2000, however, there were a few hundred marketplaces remaining. An increasing number of independent IBEMs have either expanded their

business models beyond market making, merged with other IBEMs, been acquired, or failed outright. They have also adapted and evolved into new forms. Thus we can see that the IBEMs operate in a highly competitive, dynamic, entrepreneurial and innovative environment and hence their adaptation capabilities will determine which organization will survive. Organisations operating in stable environments can adapt gradually through continuous incremental change whereas those operating in highly dynamics environments such as IBEMs, need to adapt and evolve very fast to create and sustain competitive advantage. Studying the adaptation and evolution of industries, which operate in such environments would give us valuable inputs on current/future industries operating on similar environments. The adaptive behavior of IBEMs is important due to their vulnerability to competition as they have limited cash reserves and debt capacity, over-dependence on a limited product/service line, relatively limited market presence, significant demand fluctuations and aggressive competition.

Adaptation is likely to occur in different degrees and different ways depending on where an organization is in its life cycle. In start-up entrepreneurial ventures (most IBEMs fall in this category), adaptation is critical than at any other stage in the life cycle. In such firms the products/services, customers, and marketing approaches not well established and there is also a high degree of environmental changes. Hence it would be useful to understand the adaptation and evolution of IBEMs. In this paper, we attempt to answer the following questions:

- How do IBEMs evolve and what are the stages in the adaptation of IBEMs?
- What are the key resources, capabilities and complementary assets of IBEMs at each stage of their evolution?
- What are the adaptive strategies pursued by IBEMs to leverage resources and capabilities
- Can IBEMs develop long-term competitive advantage using their internal resources and capabilities?

## 2. IBEMs: Taxonomy and organizational perspectives

The IBEMs offer services such as buyer/supplier and product/services searching, transactions such as procurement, asset disposal etc. IBEM act as Market Makers whose primary roles are to match buyers and sellers, broker deals, and facilitate transactions. Market

makers perform four basic functions such as price setting, coordinating exchange, market clearing and allocating goods and services [38]. IBEMs differ from the traditional marketplaces as they offer increased personalization and customization of product offerings, and aggregation and disaggregation of information-based product components to match customer needs.

There are various ways of classifying business-to-business marketplaces. For this research we are classifying them into public, private and consortia marketplaces. Our research focuses on public marketplaces.

*Public Marketplace:* A public marketplace, also known as neutral marketplace or third-party marketplace brings together buyers and sellers within a particular industry for the purpose of commerce. It provides content, value-added services and transaction capabilities e.g. Freemarkets. *Private Marketplace:* Private marketplaces are owned and operated by a one company to transact with a select group of suppliers. They have the potential to provide high performance and tight integration with current suppliers. Examples of enterprises that have private marketplaces include: Wal-Mart, Dell, Sun Microsystems, Amtrak, and Cisco.

*Consortia Marketplace:* Consortia marketplaces are jointly owned by several large enterprises that deploy applications and infrastructure to facilitate collaboration and conduct business among trading partners. They are highly customized and integrated with the process of its founders. They also require a large investment and have long implementation schedules.

### 3. Theoretical Framework

Research on the evolution of firms has been carried out within theoretical streams such as industrial economics, strategic management and organization theory. Some of the studies have identified multiple stages or phases of firm evolution [1] [2] [3] [4] [5] [6]. Other studies have analyzed the impact of internal factors such as resources and capabilities, organizational structure, strategy, top management team characteristics and external factors such as market structure, competition and government regulations on firm growth and survival [7] [8]. There are also studies, which draw parallels to the neo-Darwinian theory of evolution in Biology [9] [10] [11]. Adaptation strategy concerns specific ways in which the firm makes adjustments, as it seeks to survive and capitalize on external circumstances. Such adjustments can be made in a variety of product, market and resource management areas [15] such as a broader product mix, new product development, exploration of new markets and market segments, speed of response, outsourcing and resource leveraging, formation of strategic alliances etc. Organizations operating in highly competitive environments rely on strategies that are more adaptive [12] [13] as the success of a concept and a business is a function of appropriate and timely adaptation of the concept over time. However, the degrees of adaptation

that occur, and the outcomes of this adaptation, are likely to vary considerably as a function of a variety of factors [21].

The catalysts of adaptation may be internal or external. The internal catalysts could be short or long term goals. The external catalysts could be structural factors of resource dependence, or industry-based factors. Organizational punctuated equilibrium model can be used to analyse resources changes in growing ventures. We can also integrate this model with the Resource-Based Theory of the firm, by suggesting that each stage of organizational growth can be represented as a distinct configuration of resources being built by the firm to achieve competitive advantage. See *Figure 1* for a diagrammatic representation of the process of resource configurations.

A key aspect of evolution is adaptive capability to the changing environment and adaptation is an important aspect in organizational evolution. Evolution is driven by the process of interactions between organization and the environment, learning behavior, and the survival/growth strategies in different environments. Product Life Cycle models have been used to trace the product as well as organizational evolution [16] [17] [18] [19] [20]. Industries have witnessed an initial large number of competitors and later experienced a shakeout decreasing the producers. This phenomenon is common in manufacturing industries such as automobiles where many often the number of producers reduced by 50% or more during the formative times [16] [21].

The resource-based view of the firm [22] [23] [24] [25] [26] [27] [28] suggests that differences in firm performance are primarily the result of resource heterogeneity across firms. Firms that are able to accumulate resources and capabilities that are rare, valuable, nonsubstitutable, and imperfectly imitable will achieve an advantage over competitors [22] [24] [26]. Resources can be divided into physical, human, and organizational assets [23]. Capabilities are capacities to deploy resources, usually in combination, to effect a desired end [29]. Dynamic capabilities [30] is an extension of RBV approach. It explores how valuable resource positions are built and acquired over time. Dynamic capabilities are rooted in a firm's managerial and organizational processes, such as those aimed at coordination, integration, reconfiguration, or transformation [43] [44], or learning [45]. Applying the RBV facilitates a better understanding of the nature of competitive threats as it would help to identifying resources critical to gaining and sustaining a competitive advantage.

In many cases a firm's ability to commercialize an innovation may require that its internal resources be utilized in conjunction with the complementary resources of another firm. Complementary resource endowments have been noted as a key factor driving returns from alliances [46] [47] [48] [49] [50]. In the context of IBEMs complementary assets can be defined as assets that are required to gain competitive advantage from the

implementation of best marketplace practices. A new entrant wishing to duplicate them would be facing significant entry barriers including high capital costs, scale economics and learning. New businesses such as IBEMs may not be able to develop all their resources and capabilities internally and therefore it is critical to address the issue of the influence of complementary assets on the adaptation of IBEMs.

## 4. Research Design and Methodology

The study adopted two methodologies across two phases. First phase involves the usage of the case study method and the second phase adopts the case survey methodology.

### 4.1 Case Study

Adaptation is a dynamic activity that unfolds over time and hence we have adopted a case research methodology, aimed to more accurately capture the nature and degree of specific changes as they are made. Moreover the factors influencing organizational processes often include path dependencies that are cumulative and historically conditioned. Hence the research design was longitudinal in nature and was designed to enable the multiplicity of factors that may have shaped the processes. The case study strategy is particularly helpful in situations of a “phenomenon in the making” to gain novel and rich insights [73]. These are situations where there are few theoretical foundations and exact measures for the key variables. In-depth interviews were conducted and the study adopted a multi case design to allow for replication logic. To overcome the weaknesses of this approach such as the difficulty of generalizing individual case studies, multiple case studies were used.

A non-probabilistic sampling method was favoured as generalization in a statistical sense was not one of the objectives. We chose a sample from which the maximum can be learned. The following criteria were used to choose firms for case study:

- Firm is a business-to-business market maker
- Derive at least 30% of their revenues through transactions facilitated through the Internet
- Use the Internet as a key mode of delivery of their services

We chose four Indian IBEMs, which met the above criteria. (See *Table 1* for a brief description of the firms).

#### 4.1.1 Data and Analysis

Data was collected through semi-structured interviews with the CEOs, CIOs, CFOs, Vice Presidents, as well as the Managers of the IBEMs. Interviews lasted from one to four hours and an interview guide was used to avoid losing focus and to ensure that all relevant questions were asked. Questions were both closed and open-ended. Respondents were thus given the opportunity to express their thoughts on the topic of interest as freely as possible. Based on the responses, the resources and capabilities

were classified under various categories and their adaptation measures were identified (See *Table 2*).

## 4.2 Case Survey

Based on the variables captured through the above method, we conducted a Case Survey [74] [75] [76] [77] of firms based in the US, Europe, South America, Canada and Asia Pacific. Case surveys bridge the gap between surveys and case studies to combine their respective benefits of generalizable, cross-sectional analysis and in-depth, processual analysis [77].

The criteria used to choose firms for the case survey was the same as that used for the case study. For our case survey, we had a list of 135 IBEMs from across the world and data coding was carried out based on information from sources such as information from company annual reports, SEC filings, research reports, published cases, academic papers and various other sources. In addition we extensively used the WayBack Machine of The Internet Archive ([www.archive.org](http://www.archive.org)). Questions were closed ended to facilitate statistical analysis. Diverse sources of data were used as they offer multiple points of analysis into the phenomenon of interest. In addition to this, the questionnaires were emailed all the IBEMs used for the case survey. We received 37 responses and they were used to test the validity of the methodology.

### 4.2.1 Data and Analysis

The closed-ended questionnaire had 32 questions across sections such as Business Model, Customers, Environmental Characteristics, Resources and Capabilities, Alliances & Complementary Assets and Products and Services. Two raters were used to fill the questionnaire for two random samples of 25 firms across the years. Both the raters were trained in management (MBA and above). The correlation of the scores between the author's ratings and the first rater was found to be .9 and the second rater was found to be .93. Since the inter-rater correlations were high, the reliability of the author's ratings was judged to be good. Ratings were identical for 1035 out of 1150 responses between the author's and the first rater and 1070 out of 1150 between the author's and the second rater. The correlation between the author's ratings and the responses from the firm responses was found to be .94 and was also judged good. In this case the ratings were identical for 1600 out of 1702 between the author's and the firms. Based on all the responses and the ratings of the raters, the adaptation scores were calculated for all the factors (See *Figure 2*).

From the figure we can see that for almost all the factors, the adaptation scores are increasing over the years. Adaptation scores for factors such as Strategy and Vision seems to be decreasing for the year 2002, which can be attributed to the reduction in competition.

## 5. Proposed Framework

The three-stage framework proposes that firms rely on continuous adaptation to regenerate competitive advantage under conditions of rapid change. This is achieved by adapting their existing resources and capabilities, acquiring new resources and capabilities and accessing complementary resources and capabilities through alliances. Firms change what they are and what they offer through the continuous adaptation process and hence they need to regenerate competitive advantage relative to the new competitors they encounter in these domains. The adaptation and evolution of IBEMs could be described in terms of the following 3 stages: *Aggregation, Dynamic Transactions & VAS and Integration & Collaboration* (See Figure 3 for the proposed framework).

### 5.1 Stage 1: Aggregation

In this stage, the main purpose of IBEMs is to reduce transaction costs, bring together buyers and sellers as well as facilitate price discovery. They brought together buyers and sellers over a static transaction platform and there were no dynamic transactions. They had limited financial resources and limited organizational, technological as well as managerial capabilities. The key resources identified in this stage are technological resources, information based resources and financial resources. The key capabilities during this stage were technological and managerial (Sales and marketing, Strategic relationships with Venture Capitalists). Technological capabilities were difficult to obtain as there was a mismatch between the supply of capable people with the required technological capabilities and their demand. Hence all the firms had an ongoing recruitment program. Technological development activities for the web site and the new version of the technology were also considered important by all the firms. Sales and marketing abilities were considered important as this was a new business opportunity and the awareness levels of the customers was very low. Development and maintenance of critical strategic relationships with Venture Capitalists was a key capability and they considered the degree of interest of the Venture Capitalists could make or break their firms. All the firms considered the competition at this stage to be extremely high. (See Table 3 for the Resource Changes across the stages). Propositions one to six can be arrived from the above discussion.

*P<sub>1</sub> In the aggregation stage, IBEMs are at a competitive disadvantage as there are no factors, which differentiate them from the competition*

*P<sub>2</sub> The technological resources and capabilities of IBEMs built in the aggregation stage offers only short-term competitive advantage and are prone to imitation and substitution*

*P<sub>3</sub> In the aggregation stage, first mover IBEMs have marginal competitive advantage*

*P<sub>4</sub> In IBEMs, technological resources alone do not explain the significant performance variation among firms*

*P<sub>5</sub> For IBEMs, managerial, technological and organizational capabilities satisfy the resource-based criteria for being valuable, rare, inimitable and non-substitutable as they are strongly firm specific and path-dependent*

*P<sub>6</sub> In IBEMs, managerial, technological and organizational capabilities complementary to technological resources explain the significant performance variation between them*

### 5.2 Stage 2: Dynamic Transactions and Value Added Services (VAS)

Between Stage 1 and 2, there was a high degree of adaptation (D=4). A new way of delivering the services was being explored and strategic initiatives were started to access complementary assets. The IBEMs were in the process of delivering dynamic transactions and value added services. Most important characteristic of Stage 2 was the low transaction volume and the inability to achieve the critical mass of transactions (the number transactions required to achieve break-even). "We were a long way from the number of transactions required to achieve critical mass and we were running out of cash", acknowledged the CFO of Company 3. The companies were also increasing Organizational capabilities around their core technology. For example, the dynamic transactions required an entirely new set of capabilities. The IBEMs started facilitating dynamic transactions through mechanisms such as auctions and reverse auctions. They entered into alliances with partner firms to access complementary assets. Value added services (VAS) are defined as services, which supplement the actual transaction, cataloguing and search capability. The main VAS includes financial services, logistics services, analytics services, inspection, and settlement of disputes. Among these, the two most important services are credit & payment and logistics services. The IBEMs also considered order fulfillment and financial settlement as two key areas of differentiation. The importance of having financial services arises from the fact that B2B marketplaces must offer a trusted environment, because the parties do not necessarily have previous relationships and have therefore not built up any trust between them. This brings us to propositions seven and eight.

*P<sub>7</sub> In the dynamic transaction & value added services stages, first movers IBEMs have marginal competitive advantage*

*P<sub>8</sub> IBEMs access complementary assets, as the time window during which they need to succeed in commercializing their products and services is very short*

### 5.3 Stage 3: Integration & Collaboration

A major punctuated shift (the dot com bust) occurred between Stage 2 and 3. In this stage, the degree of adaptation was very high ( $D=5$ ). Most of the firms at this stage were putting on hold their expansion plans and were restructuring, downsizing and retrenching. In all the companies a number of people were laid off and the basic orientation of the company was redesigned. After that, the resources that emerge remained constant through the following three data collection phases. In Stages 2 and 3, long term contracting and service delivery became salient, in contrast to the previous focus on sales and marketing. The companies were also shifting towards services, which assured more returns such as Consulting. The knowledge base in the companies went through a lot of changes due to the lay offs as most of the firms lost about a quarter of their employees. Also as the new consulting contracts expanded, the planning and strategy formation functions became more formal. Development and maintenance of critical strategic relationships with key partners and customers was a key capability as most of the IBEMs had still not achieved the critical mass of transactions.

The IBEMs started integrating their products/services with those of their customers and thereby build switching costs. This is the stage wherein managerial, organizational or technological capabilities give the firm scope to create competitive advantage. To facilitate integration and collaboration, the IBEMs were developing competencies such as data mapping repositories including XML document exchange formats and trading partner agreements which will allow the customers to switch from one market to the other at any time. Integration also involves modeling, automating, and integrating business processes and trading relationships between partners. Integration of information refers to the sharing of information among participants of the IBEM such as buyers and suppliers. This includes data such as inventory data, demand data, capacity plans, production schedules, promotion plans, and shipment schedules. What characterizes this stage is their ability to achieve sustained competitive advantage by exploiting stage 1 and stage 2 activities. Whereas stage 2 activities involve the ability to invent and enter into alliances and exploit the same, stage 3 activities involves the ability to create interorganizational processes. This brings us to proposition nine.

*P<sub>9</sub>In the integration and collaboration stage, IBEMs have scope to create sustainable competitive advantage as they are able generate lock-in effects by integrating with the processes of its partners*

## 6. Conclusion & Future Research Directions

Figures and tables should be placed as close as possible to where they are cited. Captions should be Times 10-point boldface. Figures and tables must be numbered separately. Figure's captions should be centered below the

figures, and Table captions should be centered above the table body. Initially capitalize only the first word of each caption.

The framework aims to capture the types of resources and capabilities as well as complementary assets, which were leveraged by IBEMs at various stages and their adaptation. The framework has the advantage that its sequential mode of analysis allows to identify precisely where and at what stage the firm has built its resources and capabilities and what is their adaptation process. It is not necessary that all IBEMs must pass through all stages or must pass through the stages one at a time. Many firms do not reach stage 3 or even stage 2, and most firms contain activities that are at more than one stage. The activities at the three different stages of development of the firm are supported by different types of internal and external resources and capabilities. Thus, resources that support the stage 3 activities may be different from the type of resources that support stage 1 or 2 activities. Whereas important stage 2 resources may be complementary assets, the important stage 3 resources are managerial, organizational or technological capabilities. Moreover managerial and organizational capabilities may better satisfy the basic resource-based criteria for being rare, valuable, costly to imitate, etc. This is so because they are more likely to be strongly firm specific and hence difficult to imitate. This is due to them being internally accumulated through path-dependent processes of change. Thus, in this way the analysis of firm adaptation, the analysis of resources and capabilities as well as the analysis of sustainability of competitive advantage are merged. In order to survive and maximize economic gains, an IBEM has to reach the Integration stage. Although the IBEMs in the value added services stage have marginal competitive advantage, they can rarely demand premium for their services. On the other hand, IBEMs in the Integration stage maximize economic gains by creating stable interorganisational processes. This research contributes to a growing body of research seeking to understand the determinants of organizational ability to adapt and gain competitive advantage in new competitive and high-velocity environments by leveraging the right resources and capabilities and complementary assets. One of the important implications of our framework is that competitive advantage is associated with a process of ongoing renewal and access to resources and capabilities rather than with a favorable position in an attractive industry. Future research could be in terms of the context in which these IBEMs are operating and whether IBEMs operating in different countries or IBEMs targeting different industries show a distinct pattern of adaptation and evolution.

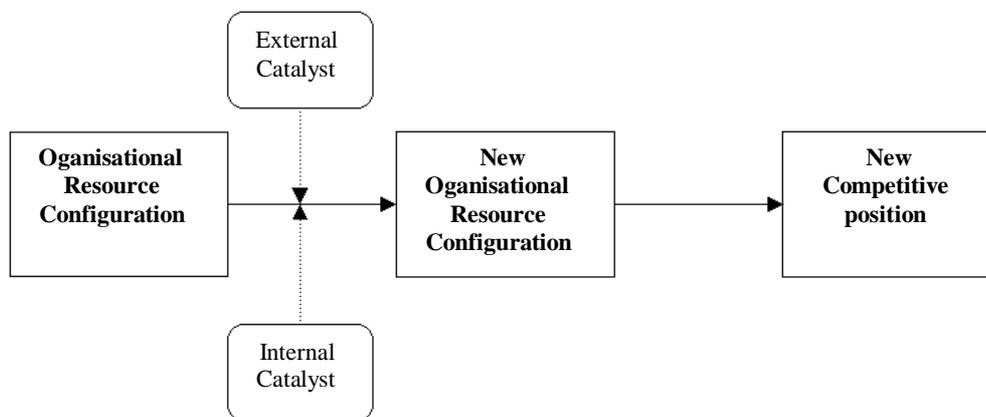
## References

- [1] L. E. Greiner, "Evolution and Revolution as Organizations Grow," *Harvard Business Review*, vol.50, pp. 37-46, 1972.
- [2] . Galbraith, "New Venture Planning—The Stages of Growth," *Journal of Business Strategy*, vol.3, pp. 70-79, 1982.
- [3] . Miller and P. H. Friesen, "A longitudinal study of the

- corporate life cycle," *Management Science*, vol. 10, pp. 1161-1183, 1984.
- [4] . Quinn and K. Cameron, "Organizational lifecycles and shifting criteria of effectiveness: Some preliminary evidence," *Management Science*, vol. 29, pp. 33-51, 1983.
- [5] R. Kazanjian and R. Drazin, "A stage-contingent model of design and growth for technology-based new ventures," *Journal of Business Venturing*, vol. 5, pp. 137-150, 1990.
- [6] Hanks, S.H., Watson, C.J., Jansen, E. & Chandler, G.N. 1993, "Tightening the life-cycle construct: a taxonomic study of growth stage configurations in high-technology organizations", *Entrepreneurship Theory and Practice*, vol. 18, no. 2, pp. 5-29.
- [7] K. Eisenhardt and C. B. Schoonhoven, "Organizational growth: Linking founding team strategy, environment, and growth among U.S. semiconductor ventures, 1978-1988," *Administrative Science Quarterly*, vol. 35, pp. 504-526, 1990.
- [8] W. Shan, "An empirical analysis of organizational strategies by entrepreneurial high-technology firms," *Strategic Management Journal*, vol. 11, pp. 129-139, 1990.
- [9] J. Hirshleifer, "Evolutionary models in economics and law: Cooperation versus conflict strategies," *Research in Law and Economics*, vol. 4, pp. 1-60, 1982.
- [10] M. Faber and J. L. R. Proops, "Evolution in Biology, Physics and Economics: A conceptual analysis," in *Evolutionary Theories of Economic and Technological Change*, P. P. Saviotti and J. S. Metcalfe, Eds.: Harwood Academic Publishers, 1991, pp. 58-87.
- [11] J. S. Metcalfe and P. P. Saviotti, (1991) *Evolutionary Theories of Economic and Technological Change*: Harwood Academic Publishers.
- [12] D. Davis, M. Morris, and J. Allen, "Perceived environmental turbulence and its effect on selected entrepreneurship, marketing, and organizational characteristics in industrial firms," *Journal of the Academy of Marketing Science*, vol. 19, pp. 43-51, 1991.
- [13] D. F. Jennings and S. L. Seaman, "High and low levels of organizational adaptation: an empirical analysis of strategy, structure, and performance," *Strategic Management Journal*, vol. 15, pp. 459-475, 1994.
- [14] B. S. Chakravarthy, "Adaptation: a promising metaphor for strategic management," *Academy of Management Review*, vol. 7, pp. 35-44, 1982.
- [15] A. Ginsberg, "Measuring and modeling changes in strategy: theoretical foundations and empirical directions," *Strategic Management Journal*, vol. 9, pp. 559-75, 1988.
- [16] M. Gort and S. Klepper, "Time paths in the diffusion of product innovations," *Economic Journal*, vol. 92, pp. 630-653, 1982.
- [17] B. Jovanovic and G. M. Mac Donald, (a) "The Life Cycle of a Competitive Industry," *Journal of Political Economy*, vol. 102, pp. 322-347, 1994.
- [18] R. Agarwal and M. Gort., "The Evolution of Markets and Entry, Exit and Survival of Firms," *Review of Economics and Statistics*, vol. 78, pp. 489-498, 1996.
- [19] S. Klepper, "Entry, Exit, Growth, and Innovation over the Product Life Cycle," *American Economic Review*, vol. 86, pp. 562-583, 1996.
- [20] R. Agarwal, "Evolutionary Trends of Industry Variables," *International Journal of Industrial Organization*, vol. 16, pp. 511-525, 1998.
- [21] S. Klepper and E. Graddy, "The Evolution of New Industries and the Determinants of Market Structure," *RAND Journal of Economics*, vol. 21, pp. 27-44, 1990.
- [22] J. Barney, "The resource-based theory of the firm," *Organization Science*, vol. 7, pp. 469, 1986.
- [23] J. Barney, "Firm resources and sustained competitive advantage," *Journal of Management*, vol. 17, pp. 99-120, 1991.
- [24] I. Dierickx and K. Cool, "Asset stock accumulation and sustainability of competitive advantage," *Management Science*, vol. 35, pp. 1504-1511, 1989.
- [25] E. T. Penrose, (1959) *The Theory of the Growth of the Firm*. New York: Oxford University Press.
- [26] R. P. Rumelt, (1984) *Towards a strategic theory of the firm*, R.B. Lamb (Ed) *Competitive Strategic*. Prentice-Hall.
- [27] R.P. Rumelt, "How much does industry matter?" *Strategic Management Journal*, 12, 167-85, 1991.
- [28] B. Wernerfelt, "A Resource-based View of the Firm," *Strategic Management Journal*, vol. 5, pp. 171-180, 1984.
- [29] R. Amit and P. Schoemaker, "Strategic Assets and Organizational Rent," *Strategic Management Journal*, vol. 14, pp. 33-46, 1993.
- [30] D. J. Teece, G. Pisano, and A. Shuen, "Dynamic capabilities and strategic management," *Strategic Management Journal*, vol. 18, pp. 509-533, 1997.
- [31] K. Eisenhardt and J. A. Martin, "Dynamic capabilities: What are they?," *Strategic Management Journal*, vol. 21, pp. 1105-1121, 2000.
- [32] D. Lei, M. A. Hitt and R. A. Bettis,, "Dynamic Core Competences Through Meta-Learning and Strategic Context", *Journal of Management*, vol. 22, pp. 549-569, 1996.
- [33] G. Hamel, "Competition for competence and interpartner learning within international strategic alliances," *Strategic Management Journal*, vol. 12, pp. 83-104, 1991.
- [34] K. Harrigan, *Strategic flexibility*. Lexington, MA: Lexington Books, 1985.
- [35] R. C. Hill and D. Hellriegel, "Critical contingencies in joint venture management: Some lessons from managers," *Organization Science*, vol. 5, pp. 594-607, 1994.
- [36] W. Shan, G. Walker, and B. Kogut, "Interfirm cooperation and startup innovation in the biotechnology industry," *Strategic Management Journal*, vol. 15, pp. 387-394, 1994.
- [37] D. J. Teece, (1987) *Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy*. Cambridge: Ballinger.
- [38] D. F. Spulber, (1998) *The Market Makers, How Leading Companies Create and Win Markets*. New York: McGraw-Hill.
- [39] J. Bailey and Y. Bakos, "An Exploratory Study of the Emerging Role of Electronic Intermediaries," *International Journal of Electronic Commerce*, vol. 1, pp. 7-20, 1997.
- [40] F. Riggins, "A Framework for Identifying Web-Based Electronic Commerce Opportunities," *Working Paper, Dupree School of Management, Georgia Institute of Technology*, 1998.
- [41] Y. Bakos, "A Strategic Analysis of Electronic Marketplaces," *MIS Quarterly*, vol. 15, pp. 295-310, 1991.
- [42] Y. Bakos, "Reducing Buyer Search Costs: Implications for Electronic Marketplaces," *Management Science*, vol. 43, pp. 1676-1692, 1997.
- [43] M. Bichler and S. Arie, "A Brokerage Framework for Electronic Commerce," *Distributed and Parallel Databases, Special Issue on E-Commerce.*, vol. 7, pp. 133-148, 1999.
- [44] R. K. Yin, (1984) *Case Study Research: Design and Methods*. Beverly Hills, CA: Sage Publications.
- [45] Lucas, W. (1974). *The case survey method of aggregating case experience*. Santa Monica, Calif.: Rand.
- [46] R. K. Yin and K. A. Heald, "Using the case survey method to analyze policy studies," *Administrative Science Quarterly*, vol. 20, pp. 371-381, 1975.
- [47] R. K. Yin and D. Yates, *Street-level governments: Assessing decentralization and urban services*, vol. R-1527-NSF. Santa

Monica, CA: Rand Corporation, 1974.  
 [48] R. Larsson, "Case survey methodology: Quantitative analysis of patterns across case studies," *Academy of Management Journal*, vol. 36, pp. 1515-1546, 1993.

**Figure 1: Process of Resource Configurations**



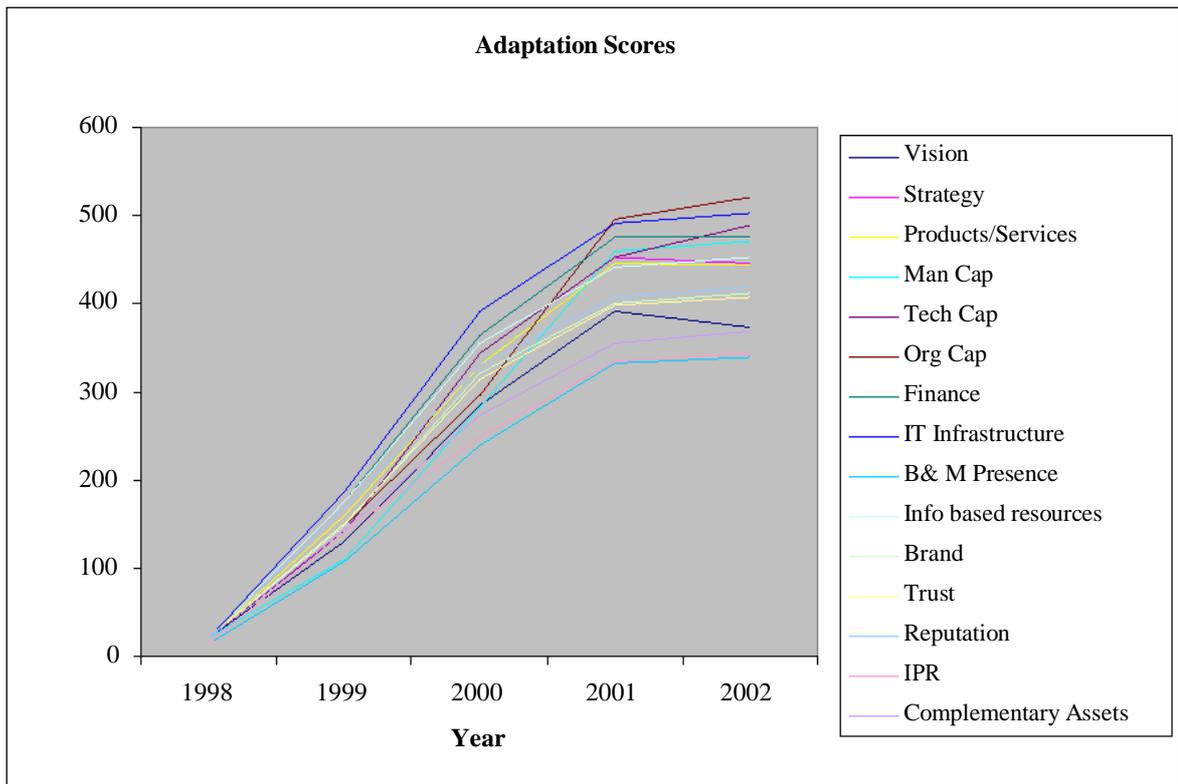
**Table 1: Brief Description of the firms used for case study**

Company description	State of adaptation	Degree of adaptation (D)
<b>Company 1</b> Business-to-business auction site targeted at industrial assets. Service launched in August 1999 No. Of employees: 40	Aggregation & static transactions (Mid to late 1999) Dynamic Transactions & VAS (2000) Integration & Collaboration (2001)	High (D=4) Between #1 & #2 Very High (D = 5) Between #2 & #3 Medium (D = 4) Current Stage
<b>Company 2</b> e-Procurement Services provider, also offers market-making services. Service launched in September 2000 No. Of employees: 63	Aggregation & static transactions (End 2000 to mid 2001) Dynamic Transactions & VAS (II half of 2001 to present) Integration & Collaboration (2001 to present)	High (D = 4) Between #1 & #2 Very High (D=5) Between #2 & #3 High (D=4) Current Stage
<b>Company 3</b> Business-to-business marketplace offering company specific Private Marketplaces The service was launched in 2000 No. Of employees: 25	Aggregation & static transactions (End of 1999 onwards) Dynamic Transactions & VAS (End of 1999 onwards)	High (D = 4) Between #1 & #2 Medium (D = 3)
<b>Company 4</b> Procurement and Asset Disposal Exchange The service was launched in 1998 No. Of employees: 70	Aggregation (End of 1999 onwards) Dynamic Transactions & VAS (2000 Onwards) Integration & Collaboration (2001 onwards)	High (D = 4) Between #1 & #2 Very High (D=5) Between #2 & #3 High (D=4)

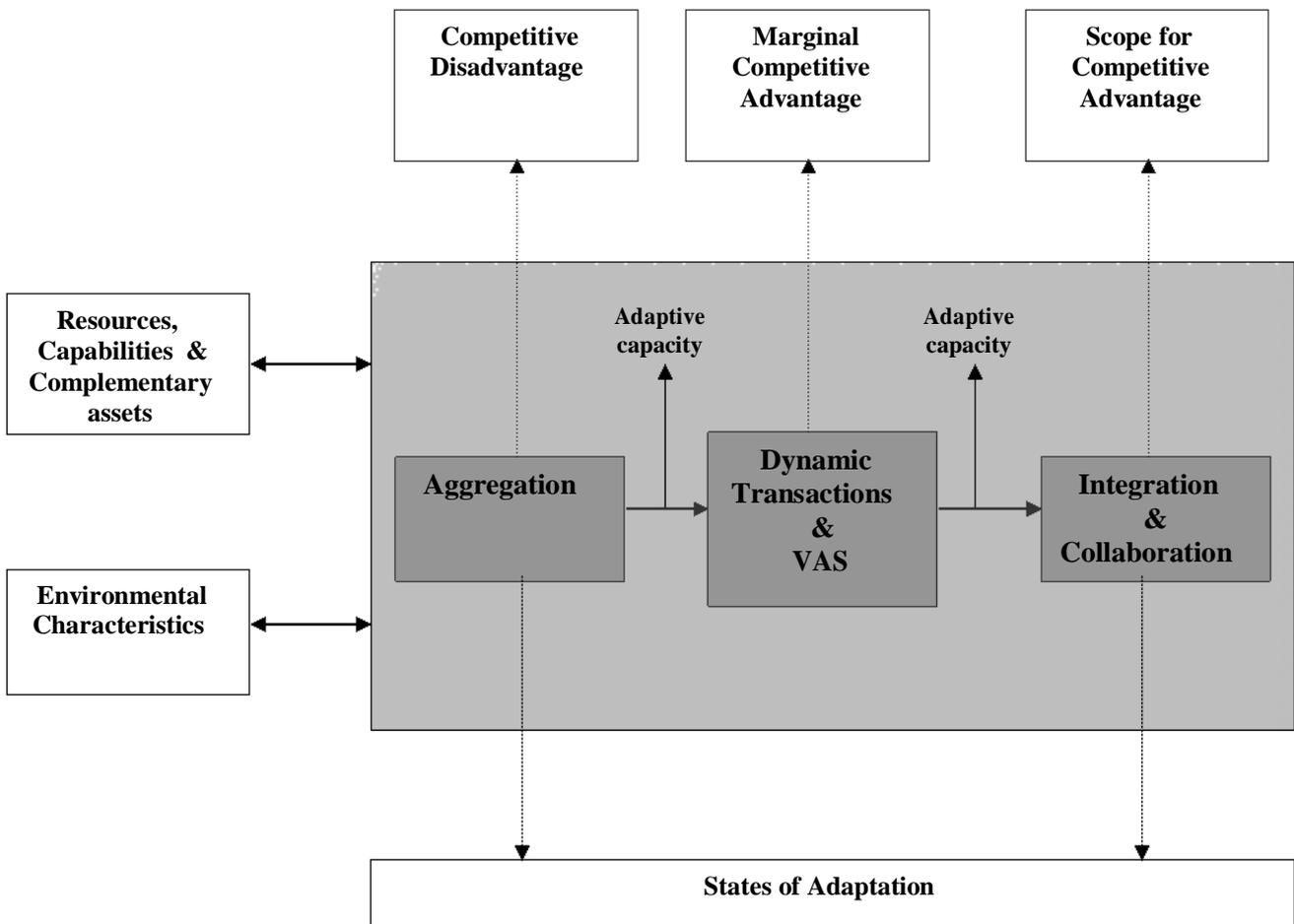
**Table 2: Type of Resources and Capabilities and their Adaptation measures**

<b>Resource &amp; Capabilities</b>	<b>Example</b>	<b>Adaptation measures</b>
<b>IT Infrastructure</b>	Web servers, PCs, System software, Databases, Data Mining, Data Warehousing, Routers etc.	◦ Has the firm developed or added to the existing IT Infrastructure?
<b>Information based resources</b>	Buyer and seller databases, catalogs etc.	◦ Has the firm developed or added to the existing Information based resources?
<b>Financial Resources</b>	Firm's ability to generate internal funds, borrowing capacity and its market value	◦ Has the firm accessed new sources of capital?
<b>Brick &amp; Mortar Assets</b>	Land, buildings and location	◦ Has the firm developed or added to the existing B&M assets?
<b>Intellectual Property Rights</b>	Patents, trademarks, copyrights etc.	◦ Has the firm developed or added to the existing IPR?
<b>Reputation</b>	Reputation with customers, suppliers, government agencies, competitors and partners	◦ Has the firm made investments to improve its reputation?
<b>Trust</b>	Confidence in the firm's quality of service, privacy and security policies	◦ Has the firm made initiatives to improve trust?
<b>Brand</b>	Distinctive product, service, or concept	◦ Has the firm made investments to promote its brand?
<b>Complementary Assets</b>	Logistics, insurance, credit, payment, rating etc.	◦ Has the firm developed or added to the existing Complementary Assets?
<b>Managerial Capabilities</b>	Knowledge, experience, account and transaction management, end user training, domain knowledge, marketing capabilities	◦ Has the firm recruited/retrained personnel, made changes to its key personnel etc.?
<b>Technological capabilities</b>	Software design, development, testing, working across multiple platforms, integration, customisation, and database management	◦ Has the firm introduced a new product /service or a new version of the existing product/service, developed new technological capabilities etc. ?
<b>Organisational capabilities</b>	Reporting structures, organization culture, innovation, responsiveness, management of alliances, training programs, R&D, knowledge creation, innovation and organizational learning	◦ Has the firm made changes to its organizational structure, entered into alliances, invested in new R&D projects etc?

**Figure 2: Adaptation Scores**



**Figure 3: Proposed Framework**



**Table 3: Resource Changes across the stages**

Stage 1 Aggregation	Stage 2 Dynamic Transactions & Value Added Services	Stage 3 Integration & Collaboration
<p><b>Managerial Capabilities</b></p> <ul style="list-style-type: none"> <li>◦ Sales &amp; Marketing</li> <li>◦ Strategic relationship with VCs</li> </ul> <p><b>Organisational Capabilities</b></p> <ul style="list-style-type: none"> <li>◦ Recruitment</li> </ul> <p><b>Technological Capabilities</b></p> <ul style="list-style-type: none"> <li>◦ Web site development</li> <li>◦ Cataloguing</li> </ul> <p><b>Financial resources</b></p> <ul style="list-style-type: none"> <li>◦ Start-up capital</li> </ul> <p><b>IT Infrastructure</b></p> <ul style="list-style-type: none"> <li>◦ Servers</li> <li>◦ Databases</li> </ul> <p><b>Information based resources</b></p> <ul style="list-style-type: none"> <li>◦ Transaction data</li> </ul> <p><b>Brick &amp; Mortar Assets</b></p> <ul style="list-style-type: none"> <li>◦ Development centre</li> </ul> <p><b>Trust</b></p>	<p><b>Managerial Capabilities</b></p> <ul style="list-style-type: none"> <li>◦ Transaction Management</li> </ul> <p><b>Organisational Capabilities</b></p> <ul style="list-style-type: none"> <li>◦ Recruitment</li> <li>◦ Training</li> <li>◦ Responsiveness</li> </ul> <p><b>Technological Capabilities</b></p> <ul style="list-style-type: none"> <li>◦ Transaction management</li> </ul> <p><b>Financial resources</b></p> <ul style="list-style-type: none"> <li>◦ Free cash flow</li> </ul> <p><b>IT Infrastructure</b></p> <ul style="list-style-type: none"> <li>◦ Data mining</li> <li>◦ Data Warehousing</li> </ul> <p><b>Information based resources</b></p> <ul style="list-style-type: none"> <li>◦ Transaction data</li> </ul> <p><b>Complementary Assets</b></p> <ul style="list-style-type: none"> <li>◦ Logistics</li> <li>◦ Authentication &amp; verification</li> <li>◦ Escrow</li> </ul> <p><b>Brick &amp; Mortar Assets</b></p> <ul style="list-style-type: none"> <li>◦ Offices at key locations</li> </ul> <p><b>Intellectual Property Rights</b></p> <ul style="list-style-type: none"> <li>◦ Trademarks</li> </ul> <p><b>Brand</b></p> <p><b>Trust</b></p> <p><b>Reputation</b></p>	<p><b>Managerial Capabilities</b></p> <ul style="list-style-type: none"> <li>◦ Strategic relationship with partners and customers</li> </ul> <p><b>Organisational Capabilities</b></p> <ul style="list-style-type: none"> <li>◦ Organisational structure</li> <li>◦ Innovation</li> <li>◦ Planning</li> <li>◦ Learning</li> <li>◦ Processes</li> </ul> <p><b>Technological Capabilities</b></p> <ul style="list-style-type: none"> <li>◦ Integration</li> <li>◦ Customisation</li> </ul> <p><b>Financial resources</b></p> <ul style="list-style-type: none"> <li>◦ Free cash flow</li> </ul> <p><b>Information based resources</b></p> <ul style="list-style-type: none"> <li>◦ Collaborative Planning, Forecasting, Replenishment</li> </ul> <p><b>Complementary Assets</b></p> <ul style="list-style-type: none"> <li>◦ Insurance</li> <li>◦ Payment</li> </ul> <p><b>Intellectual Property Rights</b></p> <ul style="list-style-type: none"> <li>◦ Copyrights</li> </ul> <p><b>Brand</b></p> <p><b>Trust</b></p> <p><b>Reputation</b></p>

# Using Association Rule Techniques to Improve Document Retrieval

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## Abstract

Document management is one of the fastest growing areas of information management. Most conventional approaches assign keywords to documents so that documents can also be retrieved through keywords. The management of data and documents are different. For example, documents have to be appeared in the full contents unlike the selected attributes are retrieved in the data queries. Also, the documents may not relevant even the values of specified attributes are identical. Moreover, documents may be related even they do not have the same keyword value. This study uses an associated knowledge rule algorithm, revised from Apriori algorithm, and classification scheme to discover the relationship between keywords of documents. The proposed algorithm can retrieve related documents without matching specified keywords in users' queries.

## 1. Introduction

Document management is one of the fastest growing areas of knowledge management. The end-user today is involved in saving, searching, scanning, routing, and revising documents, as well as choosing a system. According to O'Mears, a dynamic and intelligent document system is needed in order to resolve the challenging business environment and support decision making of good quality [1].

Document management merges with knowledge management at the level of the enterprise. Generally speaking, organizational knowledge system delivers the right knowledge to the right person at the right time in the right format to enable the right action [2]. Therefore, the role of conventional database administrators has been changed into knowledge administrators. The knowledge administrators manage not only the data but also the knowledge. The management of data and documents are not exactly the same, although both of them can be managed by relational database. To manage documents, several keywords are chosen for each document beforehand. The keywords are maintained by relational database. When users query document by specifying keywords. The system maps the specified keywords with documents, and the documents with matching keywords will be retrieved. Like database, knowledge management has its own terminology, ontologies, which define the shared vocabulary used in the knowledge management system to facilitate communication, search, storage, and

representation [6]. However, the management of data and documents are different. For example, the document has to be appeared in the full contents unlike the selected attributes in the data queries. Also, the documents may not relevant even the values of specified attributes are identical. Moreover, documents may be related even they do not have the same keyword value. This study will propose an algorithm, called associated knowledge rule algorithm, to discover the association of keywords. So that when documents are extracted from database, some related documents would also be retrieved according to the association rule even the related documents do not contain the specified keywords. This can improve the retrieving process for transactions.

## 2. Data Mining And Document Classification

### 2.1 Data Mining

Data mining, also called knowledge discovery, is a technology of finding information from data. With the universal usage of computers more data and documents are accumulated in the database. And then, data mining techniques become a useful tool to discover the knowledge from database. There are three types of data mining problems: classification problems, association problems, and sequences problems. The classification problems group the data into clusters while association problems discover the relationship between data. The sequence problems focus on the apparent sequence of data [3]. For solving these problems, there are several well-known data mining techniques, such as classification rules, discriminant rules, clustering analysis, characteristic rules, association rules, sequences search, and mining path traversal [4]. Other than that, machine-learning approaches are also being adopted. The examples include neural network, genetic algorithm, simulated annealing [5].

This research will use the association rule approach to demonstrate the characteristics of managing documents. Several famous algorithms of the association rule approach are: Apriori [3], DHP (Dynamic Hash Pruning) [4], AIS (Agrawal, Imielinski and Swami) [7], Parallel Algorithms [8], DMA (Distributed Mining of Association Rules) [9], SETM (Set-Oriented Mining) [10], and PARTITION [11]. Since the Apriori is the most illustrious, it will be used in this study. Basically, the Apriori algorithm generates higher-level of strong related entities (documents in this study) from lower-level strong related entities. It first scans database and produces single

entities from the very primal data (transaction database in this study) and select candidate entities according to the requirement of predefined support in the first round. The support is a constant to indicate the frequencies of the occurring patterns in the data set [4]. Only the entities have larger frequencies than the support value can be considered as strong related entities. And then it will produce a table of 2-entity sets in the second round based on the strong related entities of the first round. The process is repeated until different levels strong related entities are completed obtained. The association rules are acquired from different levels of strong related entities. There are several researches dedicated to improve the efficiency of the algorithm. For example, DHP [12] use a hashed table to filter the candidate entities in each round and reduce the time of counting the support of each round.

## 2.2 Classification Scheme

Due to advances in storage technology, large-scale full-text retrieval systems are available at a reasonable price. The database therefore maintains not only pure data but also full-text documents. The system accepts user search queries toward both data and documents. One way to organize a document database for a full-text retrieval system is to classify a document under one or more *classes* according to the topical domains that the document discusses. This is commonly referred to as *classification*. Traditionally, classification is done by human classifiers and therefore is slow to update and operate. Also, the classification results are highly dependent on the subjective opinions and experience of a human classifier. Fortunately, automatic classification attempts to replace human classifiers by having computers to analyze the content of a document and to assign the document to the appropriate class or classes. Automatic classification has two major components: classification scheme and classification algorithm. The classification scheme defines the available classes under which a document can be classified and their inter-relationships can be specified. On the other hand the classification algorithm defines the rules and procedures for assigning a document to one or more classes defined in the classification scheme.

Most of time the classification is based on keyword subjects of documents or system vocabulary. The keywords are normally the key terms of documents while the system vocabulary consists of subject thesaurus. Most computer systems adopt both the controlled vocabulary and keywords as the subject terms to represent the documents. Moreover, information such as author's name, date of publication, and language can also be used for searching. The indexed documents are kept in the document storage while the document representations—that is, surrogates such as keywords, vocabulary, and so forth—are used for matching. Both the documents and surrogates are stored in the database for future searches. Using this approach, the retrieval process

will be very efficient.

## 3. Using Association Rules to Discover Knowledge

This study argues that discovering knowledge from documents is different from data in the following ways:

1. The document has to be appeared in the full contents unlike the selected attributes in the data queries.
2. The documents may not relevant even the values of specified attributes are identical. For example, two documents having value of *virus* in a keyword attribute do not mean that they are in the same category. In fact, one document may belong to computer science and the other can be an article published by Department of Health.
3. Both SQL keywords search and full-text browsing can be used to search documents.
4. The Boolean operation can be used to filter the queried documents in exact match, but is not appropriate for mapping to related terms.
5. The association rule can be used to discover the documents even without specified keywords. Referring the classification scheme as described in session 2 can do this.
6. The classification scheme can be updated by association rules.

Section 3.1 describes the framework of this study while using Apriori algorithm is presented in session 3.2. An algorithm for applying association rule is discussed in session 3.3.

### 3.1 The Framework of Document Knowledge Discovery

Most of current system maintains documents in the relational database. The documents are allowed to assign numeric keywords and the keywords are used to retrieve documents. The keywords of documents are constructed into relations of relational database in the keyword database. The users type-in segmented words as anchored to query documents. During query processing, Boolean operation can be further used to limit the query results queried by the segmented words. However, the conventional approach cannot retrieve a document without specified keywords. This is why association rule technique can improve the knowledge discovery of documents. The association rule identifies the occurrences of entities and discovers the relationship between entities. The Apriori algorithm of association rule techniques analyzes the transactions and determines the strong related entities. However, as will be shown in the example of session 4, some irrelevant documents may be erroneously identified. For example, the virus can infect both human and computers. But, it will be considered as two different subjects if we are discussing about virus infection. In this case, the classification scheme is used to recognize the

subjects of keywords. The keywords are classified into different subjects classes in the classification scheme. The entities belonged to different subjects should not be retrieved as the related document. That is, the classification scheme can distinguish the difference between computer virus and virus disease. Then, the association rule is memorized as associated knowledge rules. Therefore, combining both associated knowledge rules and classification scheme, the documents having matched keywords and related words will be returned to users.

### 3.2 Mining Association rules and Apriori algorithm

Given a knowledge database, the association rules search for the relations between ontologies (keywords of documents) such that the presence of some ontologies will imply the presence of other ontologies when the same knowledge (document) are retrieved. Let  $K = \{k_{11}, k_{12}, \dots, k_{1n}, k_{21}, k_{22}, \dots, k_{nm}\}$  as the set of ontologies. Let  $D_i$  of  $D$  be a set of retrieved objects where  $K_{ij} \subseteq D_i$ . Each transaction  $t_i$  in  $T$  is represented as a set of ontologies such that  $T \subseteq D$ . Let  $A$  be a set of objects and a transaction  $t_i$  is said to contain  $A$  if and only if  $A \subseteq T$ . Also, let  $X$  be a set of ontologies and a transaction  $t_i$  is said to contain  $X$  if and only if  $X \subseteq T$ . An association rule is an implication of the form  $X \Rightarrow Y$ , where  $X \subseteq T$ ,  $Y \subseteq T$ , and  $X \cap Y = \emptyset$ . The rule  $X \Rightarrow Y$  holds in the transaction set  $T$  with confidence  $c$  if  $c\%$  of retrieves in  $T$  that contain  $X$  also contain  $Y$ . The rule  $X \Rightarrow Y$  has support  $s$  in the transaction set  $T$  if  $s\%$  of transactions in  $T$  contain  $X \cup Y$ . Note that the confidence denotes the strength of implication and the support indicate the occurring patterns in the rule [4]. Apriori algorithm scans the transaction database and counts the occurrences each entity and generates a 1-level document relationship. Then the occurrences are filtered by the predefined support. Then it generates 2-level documents according to the Cartesian product  $L_k * L_k \subseteq I_i \cup I_j \mid I_i, I_j \subseteq L_k, \mid I_i \cup I_j \mid \subseteq k \subseteq I$ , where  $k$  is the entities level,  $L_k$  is the strong entities of the  $k$  level and  $I_i, I_j$  are the entities of  $L_k$ . Then it filters 2-level entities according to the predefined support.

### 3.3 Associated Knowledge Rules

The associated knowledge rules are obtained from applying the association rule technique toward both the document database and transaction database. The Apriori algorithm of the association rule techniques is adopted in this study. This algorithm evaluates the occurrences of entities (documents) and only the occurrences over the predetermined support value will be adopted. The support value specifies the minimum strongly level of entity relationship. The Apriori algorithm begins with finding the

occurrence of one entity and then reaches occurrence of higher levels entity. To simplify the problem illustration, the algorithm of associated knowledge rules only adopts 2-entity generation. The higher degree can be implemented in the similar manner.

## 5. Conclusion

This study revised the Apriori algorithm of association rules into an associated knowledge rule algorithm. The algorithm can discover the relationship between keywords of documents. By using both the associated knowledge rules and classification scheme, the related documents without specified keywords can also be retrieved.

## References

- [1] O'MEARA, D., Oct. 2000, Buried in documents? *Engineering Management Journal*, 10(5), 241-243.
- [2] DIENG, R., Knowledge management and the internet, May-June 2000, *IEEE Intelligent Systems*, 15(3), 2000, 14-17.
- [3] AGRAWAL, RAKESH, IMIELINSKI, TOMASZ, and SWAMI, ARUN, DEC 1993, Database Mining: A Performance Perspective, *IEEE Transaction on Knowledge and Data Engineering*, 5(6), 914-925.
- [4] CHEN, MING-SYAN, HAN, JIAWEI, and YU, PHILIP S., DEC 1996, Data Mining: Overview from a Database Perspective, *IEEE Transactions on Knowledge and Data Engineering*, 8(6), 866-883.
- [5] BERRY, MICHAEL J. A. and LINOFF, GORDON S., 1997, *Data Mining Techniques, For Marketing, Sales, and Customer Support*, (New York: John Wiley & Sons, Inc.)
- [6] Daniel E. O'Leary, 1998, Enterprise Knowledge Management, Computer, Volume: 31 Issue: 3, March 1998, P54-61
- [7] AGRAWAL, RAKESH, IMIELINSKI, TOMASZ, and SWAMI, ARUN, MAY 1993, Mining Association Rules between Sets of Items in Large Databases, *Proc. of the 1993 International Conference on Management of Data (SIGMOD-93)*, 207-216.
- [8] AGRAWAL, RAKESH and SHAFER, JOHN C., DEC 1996, Parallel Mining of Association Rules, *IEEE Transaction on Knowledge and Data Engineering*, 8(6), 962-969.
- [9] CHEUNG, DAVID W., NG, VINCENT T., FU, ADA W., and FU, YONGJIAN, DEC 1996, Efficient Mining of Association Rules in Distributed Databases, *IEEE Transactions on Knowledge and Data Engineering*, 8(6), 911-922.
- [10] HOUTSMA, MAURICE and SWAMI, ARUN, JUL 1995, Set-oriented Data Mining in Relational Databases, *Data and Knowledge Engineering*, 17, 245-262.
- [11] AGRAWAL, RAKESH, MANNILA, SRIKANT, RAMAKRISHNAN, TOIVONEN, HANNU, and VERKAMO, A. INKERI, 1996, Fast Discovery of Association Rules, *Advances in Knowledge Discovery and Data Mining*, AAAI press, 307-328.
- [12] J-S Park, M. -S Chen, and P. S. Yu, 1995, An Effective Hash Based Algorithm for Mining Association Rules, *Proc. ACM SIGMOD*, 175-186.

# Peer-to-Peer Knowledge Management: Overcoming Bottlenecks and Improving Information Quality

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## Abstract

Access to current, complete and relevant knowledge is a key competitive differentiator in the present economic market space. But most knowledge management today only shifts the traditional, expert-based KM processes onto electronic media. This paper discusses a paradigm shift from an expert-centric to a peer-to-peer approach to knowledge creation and management. Leveraging the lowered transaction costs provided by Internet technology, methods and tools of collaboration that have been invented and refined by the Open Source and Free Software community over the last two decades are now being adopted by early movers in the Knowledge Management space. This new approach, based on a peer-to-peer approach and open collaboration, has shown the potential to revolutionize the way knowledge is created, developed and managed. We outline the characteristics of the two opposing paradigms and present ways in which the peer-to-peer knowledge management approach is already being successfully used in practice today. We address how the quality of information is kept high without a traditional review/quality-check role by using a revision control system and distributing the task to all interested practitioners. Finally, we discuss four key challenges for introducing the new paradigm within companies.

## 1. Introduction

“Science is the belief in the ignorance of experts.”  
(Richard P. Feynman, Nobel Laureate, Physics [4])

Several upheavals in the competitive landscapes in recent years have demonstrated that a defining characteristic of electronic business is the disruption of both current market equilibriums and current economic models by technology radically lowering transaction costs.[2] Phenomena like peer-to-peer file-sharing, networks such as Napster and Gnutella [12], or the success of Open Source software such as Linux (an “impossible public good” according to traditional economic theory) [16] [10] prove that the Internet radically changes the way we communicate and collaborate by reducing the cost associated with communication and collaboration

This paper discusses how a paradigm shift from an expert-centric to a peer-to-peer approach to knowledge creation and management has been enabled by using concepts, tools and methods developed in the open source and free software community over the last two decades.

Information today is mostly created, quality-controlled and disseminated in a closed, centralized fashion with a clear distinction between producers and consumers – just like software used to be.

Yet several high-profile initiatives using a peer-based, open source approach to collaboratively create and develop knowledge have already been launched, mainly in academic, educational and research environments (i.e. MIT OpenCourseWare, Harvard OpenLaw, Wikipedia [9] [5] [17]).

While these environments are obviously conducive to such an open model (with the scientific principle based on openly publishing results to enable replication and peer-review) this new approach can also be used inside a commercial organization that is challenged with a need to rapidly develop, update and share information. It is especially applicable when the knowledge about an issue is not (yet) a solid, coherent, structured body of information that can be easily taught, but rather still an evolving system of bits and pieces of knowledge, that has yet to reach maturity. Some people would argue that with the world around us growing more complex and changing ever faster, most of the knowledge fits the latter description.

Knowledge with these still “imperfect” characteristics is created, developed and managed in essentially open systems. We will discuss the four key obstacles for the realization of a Peer-to-Peer Knowledge Management system in companies with regard to:

- Information quality
- Issues concerning confidentiality
- The need for transparency and accountability
- The necessity to implement organizational and cultural changes

## 2. Peer-To-Peer Knowledge Management

Presently, the idea of Peer-to-Peer Knowledge Management is mostly a grass-roots movement, much the way the idea of open source software first entered corporations below the radar screen, based purely on its practical utility in solving certain problems.

One problem that has been known for some time is the aging of information both between the creation and initial publication and the “aging” of published information that becomes outdated because the world it describes relates to has changed.

The first challenge, which is especially felt in the rapidly developing fields of knowledge such as

biotechnology or particle physics, has been met by researchers publishing their papers first on pre-print servers, in order to get the information out in time to be relevant. The traditional publication, months later, is more pro-forma, as the active researchers have already read the electronic version. While this process speeds up the time to publication, it does not address the problem of information becoming outdated quickly. A method that has been developed to address this latter problem exists in so-called “Wiki Webs”s [8] for supporting collaborative, peer-to-peer knowledge creation and management, which have been increasingly appearing in research, but also corporate environments over the last few years. (Fig. 1)

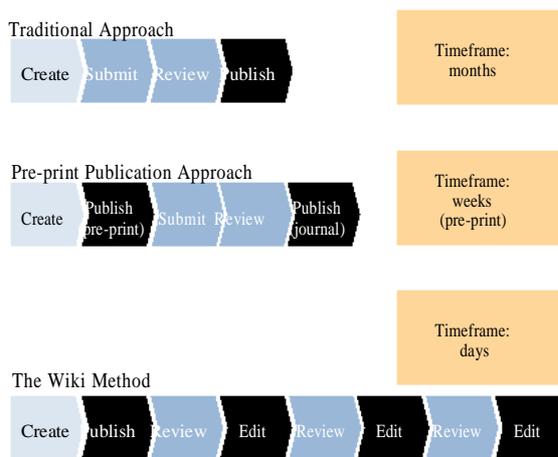


Figure 1: Three approaches to publishing knowledge.

A “Wiki” (Hawaiian for “quick”) is a collaborative knowledge management environment that eliminates the distinction between expert writers and lay readers, producer and consumer of information by making all users information “prosumers”.

In such an open, peer-to-peer context, every user can create and edit information without the bottleneck of a moderator or web-master having to approve or effect the changes. Quality is managed by keeping all changes in a detailed revision control system so that any unappreciated change can be undone by subsequent readers/editors. As an additional disincentive to low-quality contributions, the identity of the author of every change is stored and available to all users.

While such an open approach is certainly not a solution for legally binding or official information, it can be a good, evolving breeding ground for quickly documenting and formulating ideas together.

### 3. Paradigms: Brooks’ Law vs. Linus’ Law

In order to understand the issues connected with implementing such an open, peer-to-peer approach to knowledge management inside a company – and the related tricky organizational challenges – we compare and discuss several aspects of the two competing paradigms. These are exemplified by a number of opposing concepts. (Fig. 2)

Our traditional paradigm of collaborative development, such as Brooks’ Law (named after Frederick P. Brooks, author of “The Mythical Man Month” [1]) can be paraphrased as “Many cooks spoil the broth”. In accordance with this belief, only a small and select circle of designated “experts” should be allowed to create and improve high quality information, relegating the vast majority of practitioners to pure consumers of the information produced by the experts. On the other hand, Linus’ Law, named after Linus Torvalds, a term coined in the context of Open Source development [16], can be paraphrased as “The more, the merrier” and predicts that the more people are involved with (and spend their attention on) an information product, the higher the quality will be.

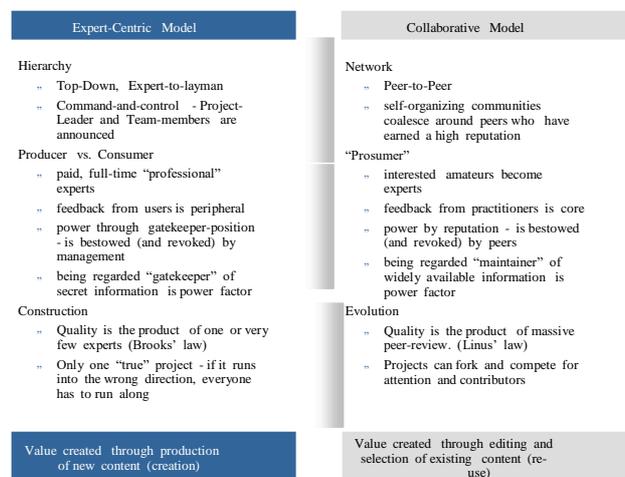


Figure 2: Expert-centric vs. collaborative model

In essence, the traditional, expert-based approach to Knowledge Management is a “construction” or “perfection” approach. Consistent with the high transaction costs for information in previous years, a static, “perfect” document was to be created before the expensive reproduction process and effective publication commenced. However, given the negligible cost of electronic publication, the open, peer-to-peer approach relies on “evolution” or “improvement” over continuing releases rather than initial perfection [11]. Eric Raymond calls this policy “release early, release often” in his famous essay The Cathedral and the Bazaar [14].

In the context of knowledge, Ives & Jarvenpaa predict a “revolution in knowledge creation”, as the review process becomes more open and the documents less static. “In the past, journals were archived in research libraries where they remain unchanged. But living web documents are considerably more volatile. Simple errors, typographic and otherwise, can be quickly repaired before they are inaccurately cited.” [7]

Other opposing concepts in this context are:

Traditional approach vs. Open, Peer-to-Peer approach

Brooks' Law	vs.	Linus' Law
Hierarchy	vs.	Network
Experts	vs.	Peers
Teams	vs.	Communities
Cathedral	vs.	Bazaar
Construction	vs.	Evolution
Perfection	vs.	Improvement
Information scarcity	vs.	Attention scarcity

### 3.1 Hierarchies vs. Networks

Let us examine some of these concepts in greater detail. Hierarchical structures are very good at getting well-defined tasks done in a “divide and conquer” paradigm. But the key challenge of knowledge management today is not dividing the work, but rather sharing the knowledge. Yet for facilitating the free exchange of knowledge, a network structure (such as peer-to-peer) is inherently better equipped than a hierarchy. From an information sharing standpoint, a hierarchical, tree-like organization is a worst-case scenario because it is a collection of bottlenecks: There is only one “official” path between any two nodes in the graph and the likelihood of people sharing information can drop as a function of their distance in the corporate org chart if alternative venues (physical or virtual) are not provided to support knowledge sharing.

Because the bottlenecks can be overworked, on vacation, or simply disinclined to pass on information and instead decide to keep it for themselves as a strategic advantage.

This does not mean that we would advise to attempt to run a company in a peer-to-peer fashion, but for the special tasks of sharing and improving the collective knowledge, a peer-to-peer network poses far fewer problems in terms of bottlenecks and re-inventing the wheel.

### 3.2 Experts vs. Peers

In a world of readily available information, the traditional distinction between “expert” and “laymen” blurs and in many respects, we become “peers” with people even on “their” home turf. For example, with the amount of medical information available online, many sufferers of chronic diseases have joined together in virtual communities to exchange information on their common ailment. Medical doctors have been faced with increasingly well-informed patients over the last few years – which is not surprising: If you have the time and obvious motivation to dissect and digest all available new information on your particular disease with a community of like sufferers, spending hundreds of hours educating yourself on all aspects – who is going to be the expert on your disease when you go to your general practitioner? Is it sensible to label the MD “expert” and you “layman” with respect to this niche of knowledge?

This is something we are seeing in many areas. Another interesting clash between “expert” and “layman” is the famous public debate between Tanenbaum and Torvalds over whether Linux had any future held on Usenet in 1992.

Professor Tannenbaum, the prominent and recognized expert on operating systems, predicted that Linux would never be portable, i.e. run on another processor than the x386. Linus Torvalds, the computer science student, defended his idea against the expert. Today, Linux is known as the most portable operating system of all times – running on everything from embedded systems, PDAs, PCs, up to supercomputers and mainframes [3].

In this case again, the traditional distinction between expert and layman is not helpful to decide who had the more worthy input. Note that in the traditional, pre-Internet world, the layman would never have had the chance to publicly debate with the expert in a way that gives both an equal footing in the debate.

### 3.3 Teams vs. Communities

Some people have taken to calling teams “communities” because this term has become a focus of attention in the knowledge management space, especially in the context of Communities of Practice. But the two terms are not interchangeable. A team is simply a group of people who have been assigned a certain task together. A team usually has a formal, appointed leader who can wield authority over the others. A team is given goals by which it is measured. It is clear at any time who is a member of the team and who is not – the boundaries are clear. And, most importantly, team members are selected by management.

A community, as in a Community of Practice, however, is a different story. Communities usually do not have a formal leader with authority over the community members. That does not mean that all members are equal – far from it: A community usually has very different roles. A coordinator may exist, and leaders who are valued as advisors by their colleagues will usually either emerge, or may have been the community’s attractor in the first place. But any authority they wield is usually not formally bestowed by management. This is because of another important attribute: Members of communities are volunteers. They choose to interact, to share information on a common set of problems or interests. They decide their level of activity or inaction. Members are not primarily measured by their activities in the community. And communities do not have clear boundaries. There will be different roles with different levels of involvement, such as community elders, “newbies”, “lurkers” (those who read but rarely contribute), FAQ maintainers, etc. Also, the level of members’ activity changes over time to accommodate their knowledge sharing needs.

### 3.4 Information vs. attention scarcity

Information used to be expensive and difficult to access. Those who had access to privileged information, through professional associations, a corporate library or at university, were at a clear advantage.

But today, using internet technology, being denied access to information is no longer a problem in most areas. You can get the most current, cutting edge research articles in physics from pre-print servers on the internet half a year

before they are ever printed and put into a library. Today the problem is the huge information overflow.

Thus the scarce resource is no longer the available information, but the available limited attention we can spend on the information glut. This has been likened to trying to drink from a fire-hose. Therefore, the focus of knowledge management is no longer on storing and indexing the few “holy scriptures” for a given subject, but rather on helping us to sift through the millions of pieces of information and putting them together in a way that makes sense. It is less the creation of new knowledge from scratch, but rather the combination and smart re-use of existing information. This is also why Communities of Practice play such an important role: Every member serves as eyes and ears for the thematic community and helps filter out the relevant pieces from the information flood. These pieces can then be assembled by the community of peers to gain and document new knowledge. The Usenet FAQs are a good example of this. They direct our limited attention and allow us to optimize our time.

### 3.5 Key benefits

The key benefits associated with an open, peer-to-peer knowledge management approach are

- f* much higher speed of content creation, capture and development
- f* broader collaboration and use of skills
- f* getting know-how out of people’s minds and desktop computers and into the open
- f* increased transparency and accountability
- f* more efficient re-use of existing assets (less “re-inventing the wheel”, more “standing on the shoulders of giants”) and
- f* dramatically reduced bottlenecks for the flow of information.

## 4. Overcoming obstacles to P2P KM

But reaping the benefits of the peer-to-peer paradigm on a larger scale inside a company requires overcoming a number of concerns and obstacles.

### 4.1 Information Quality

Electronic business relies on quick, easy and cheap exchange of information. It is an often raised argument that by empowering regular employees to be not just a consumer, but also a producer of information, the quality of information is diluted. Only the experts, the argument goes, should be allowed to create, review and update information on a corporate intranet, in order to assure high quality. But quite on the contrary, it has been demonstrated numerous times that massive peer review and participation in reviewing and editing information can actually lead to higher information quality than traditional approaches based on the review of only a few designated experts. This has not only been shown in the area of Open Source development and documentation, but also regarding traditional journal publication (i.e.

PublicLibraryOfScience.org [6]).

Indeed, there has been a recent case of large-scale scientific fraud, where a prominent researcher was able to publish 16 different papers in traditional, respected science journals, without the fraud ever being noticed during the 16 review processes. Only a tip-off by a peer brought the house of lies tumbling down [15].

### 4.2 Confidentiality

Confidentiality and intellectual property issues are part and parcel of corporate life. I.e. a consulting client may require strict non-disclosure agreements to protect his assets. Of course, this makes a peer-to-peer approach to knowledge management more challenging. However, corporations have dealt with confidentiality issues for a long time and have developed proven methods for coping with them, e.g. judicial, administrative and technical solutions. The real task at hand is questioning the basic notion that knowledge created in one team or department should be kept secret from another at all, as this creates corporate fiefdoms, silo thinking and leads to re-inventing of wheels.

Of course, in day-to-day reality, “keeping information secret” is not usually the result of a conspiracy or stubbornly denying access, but a brew of lack of transparency, lack of (default) access rights and non-publication of pointers to the information. You can theoretically track down the information if you know it exists – but the chances of finding it serendipitously are very slim.

### 4.3 Transparency

It appears that many of the concerns and fears regarding quality and confidentiality are in fact a reaction to the greater transparency associated with an open, peer-to-peer approach to knowledge management. This may be disconcerting to some people. With an open, peer-to-peer approach to knowledge management, people outside the designated “expert” team get to review, comment on and improve the available information. To quote Linus Torvalds [16]:

“In that regard, open source – or open anything, for that matter – is unforgiving. It shows who can get the job done, who is better. You can’t hide behind managers.”

This new degree of accountability can understandably appear threatening to some who are relying on traditional, non-transparent approaches to sustain their expert status.

But it is precisely this transparency that creates an incentive to share rather than hoard information. The decision for knowledge workers to share or not share their information in a situation where their decision is not transparent to a large number of their colleagues, can be modeled as a simple prisoner’s dilemma. Defecting (using information provided by colleagues but not providing any information yourself) is the rational strategy, as it maximizes your gains. The adverse effect to your reputation is negligible, if your behavior is only apparent to one colleague at a time. This is typically the case when

there is no “shared space” with easy write-access for exchanging information, but rather an official knowledge database that is filled with information through a standard process and used mostly in “read-only” fashion by the knowledge workers.

The picture changes dramatically when we introduce true shared spaces, such as newsgroups, discussion boards, team-rooms or Wikis. Non-compliance with a request for sharing information will result in significant damage to ones reputation, if both the request for help and the non-cooperation can be witnessed by many colleagues. This will lead them to one of two conclusions: A) the self-proclaimed “expert” refuses to cooperate or B) the self-proclaimed “expert” has no valuable knowledge to share.

The first conclusion lowers the expert’s social standing, the second lowers his professional standing with his peers. In such a “shared space” setting, it is likely that the role of experts as valued advisors will quickly pass from those who hold an “official” title to those who are actually willing and able to help you in your day-to-day work. This creates an internal marketplace for information, where an expert reputation has to be earned, rather than bestowed.

Our prisoner’s dilemma is also transformed: From the simple prisoner’s dilemma to the iterated prisoner’s dilemma, which is played with the same partners over extended periods of time and where the history of previous actions of all partners are visible and available to all players. In this setting, cooperation becomes the rational choice, as the reputation based on previous defection or cooperation behavior becomes a significant asset. Nobody is going to play cooperation with a known defector, whereas the known cooperators can optimize their mutual gain in the long run.

#### 4.4 Organizational and Cultural Change

Therefore, the concerns of the employees have to be mitigated by a culture that encourages experimentation and failure over inertness and perfection. Only in such a “forgiving” environment will employees feel confident to experiment with and vent new and “half-baked” ideas, which can then be developed and brought to perfection in a collaborative approach. A culture will need to be established in which the incentive for sharing information is greater than the benefit of hiding it.

This is possibly the hardest part of implementing a peer-to-peer approach. An organization is a very complex system of human actors, with their different needs, motivations and expectations set within org charts, processes and both written and unwritten laws governing behavior. Any change is likely to be rejected unless introduced, motivated and managed properly. And the transparency awarded by an open approach to knowledge management is very different indeed from the way most organizations organize knowledge management today – as a form of electronic library, focusing on storage and retrieval rather than creation and development.

## 5. Conclusion

The application of peer-to-peer concepts to knowledge management has the potential to improve the quality, currency and comprehensiveness of a company’s readily available internal knowledge by an order of magnitude.

With Internet technology at our disposal, we have the necessary tools in various different flavors. But the key challenge for the success of a peer-to-peer knowledge management is the creation of a cultural foundation which encourages and rewards transparency over information hiding. It requires the sponsorship and political will to “rock the boat” and to threaten the positions of information gatekeepers where they are more of a burden than a boon. Only an environment where every practitioner of information can also easily internally publish without going to a gatekeeper, only when the child (intern) can publicly call the emperor (expert) naked is the necessary feedback in place to keep improving the internal knowledge at a pace that keeps up with the needs of knowledge workers.

Tools can make this transition easier, but the key component of modern knowledge management is the support of the practitioners themselves. You cannot force a knowledge worker to share his knowledge. Today, we see the focus of Knowledge Management moving beyond IT into organizational and cultural change issues. The solution of which, while very challenging, also hold yield the rich rewards for an organization in terms of speed, adaptability and competitiveness.

## References

- [1] Brooks, F. P. *The Mythical Man-Month*, Addison Wesley, 1975.
- [2] Coase, R.H. *The Firm the Market and the Law*, University of Chicago Press, 1988.
- [3] DiBona, C., Ockman, S., & Stone, M. (Eds.). *Open Sources: Voices from the Open Source Revolution*. O’Reilly, 1999.
- [4] Feynman, R. P. *The Pleasure of Finding Things Out*, Perseus Publishing, 1999.
- [5] Harvard OpenLaw Project. <http://eon.law.harvard.edu/openlaw/>
- [6] Karow. “Publish Free or Perish.” *Scientific American*, April 2001. <http://www.scientificamerican.com/explorations/2001/042301publish>
- [7] Ives, B. & Jarvenpaa, S. L. “Will the Internet Revolutionize Business Education and Research?” in: Smith, D. E. (Ed.) *Knowledge, Groupware and the Internet*. Butterworth-Heinemann, 2000.
- [8] Leuf, B. & Cunningham, W. *The Wiki Way: Quick Collaboration on the Web*. Addison-Wesley, 2001
- [9] MIT OpenCourseWare Project. <http://web.mit.edu/ocw/>
- [10] Moody, G. *Rebel Code: The Inside Story of Linux and the Open Source Revolution*, Perseus Publishing, 2001
- [11] Neus, A. “Managing Information Quality in Virtual Communities of Practice,” In: Pierce, E. & Katz-Haas, R. (Eds): *Proceedings of the 6th International Conference on Information Quality at MIT*.

- [12] Oram, A. (Ed.) Peer-to-Peer: Harnessing the Benefits of a Disruptive Technology, O'Reilly & Associates, 2001.
- [13] Public Library of Science Project. <http://www.PublicLibraryOfScience.org>
- [14] Raymond, E. S. The Cathedral and the Bazaar. O'Reilly & Associates, 2001. <http://www.tuxedo.org/~esr/writings/cathedral-bazaar/>
- [15] Stieler, W. "Tiefer Fall: Skandal um Datenfälschung erschüttert Bell Labs", C'T Magazin für Computer und Technik, 21/2002, 66-67.
- [16] Torvalds, L. & Diamond, D. Just For Fun. The Story of an Accidental Revolutionary, Harper Business, 2001.
- [17] Wikipedia: The Free Encyclopedia. <http://www.wikipedia.com>
- [18] WikiWikiWeb. <http://c2.com/cgi/wiki?WikiWikiWeb>

# A Framework for Enterprise Knowledge Discovery from Databases

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## Abstract

Knowledge discovery from large databases has become an emerging research topic and application area in recent years primarily because of the successful introduction of large business information systems to enterprises in the electronic business era. However, transferring subjects/problems from managerial perspective to data mining tasks from information technology perspective requires multidisciplinary domain knowledge. This paper proposes a practical framework for enterprise knowledge discovery in a systematical manner. The six-step framework employs the cause-and-effect diagram to model enterprise processes, tasks and attributes corresponding diagram to define data mining tasks, and multi-criteria method to assess the mined results in the form of association rules. This research also applied the proposed framework to a real case study of knowledge discovery from service records. The mining results have been proven useful in product design and quality improvement and the framework has demonstrated its applicability of guiding an enterprise to discover knowledge from historical data to tackle existing problems.

**Keywords:** *knowledge discovery, data mining, association rules, cause-and-effect diagram, MCDM*

## 1. Background and Motivation

With the maturity of technology in business information systems, enterprises successively introduced large systems such as ERP, EC, SCM, CRM, etc. [1]. As information technology advances, it is a major issue an enterprise has to face to enhance competitiveness by acquiring useful analyzed information or knowledge to develop a more effective competition pattern or improvement strategy. But while enterprises obsess large bunches of data, they need a practical framework to analyze the data and discover knowledge using data mining methods [2].

In the process of enterprise decision-making, it is common to rely on decision-makers' experiences. But it may lead decision-makers to misjudgments not only because of the shortage of information in objective environment but also because of personal subjective preferences. Solving problems with traditional expert systems requires the establishment of enormous data and traditional discussions to locate problems and suitable solutions. The process of collecting data and searching feasible solutions, however, is very complicated. And

the knowledge base is often incomplete and soon to become outdated.

This research presented a framework to help enterprises analyze interesting subjects, either operational or managerial, locate subjects to be explored, and discover knowledge from existing databases through systematical steps with data mining and other problem analysis technologies.

## 2. Literature Review

Processes that consist of tasks are building blocks of an enterprise from the perspective of operations management, both for manufacturing and service industries. The competitiveness of an enterprise is therefore heavily dependent on the efficient operations and management of the processes. Over the decades, various technologies and researches have been devoted to improve it, such as total quality management (TQM), just in time (JIT), business process reengineering (BPR), and enterprise resource planning (ERP). Many of them are operations research and quantitative approaches, while some are managerial or philosophical approaches. And these approaches all attempt to make the processes fulfilled efficiently and correctly at lowest costs and highest quality. Along with the introduction of ERP systems, all the data about the historical, ongoing, or future processes are all stored in the databases. However, there are more than a thousand tables in the database for a large ERP system, and the significant amount of transactions in the database make it impossible to analyze efficiently solely with traditional statistical methods. Data mining is such a new emerging technique that has gained the significant attentions and applications of practitioners.

The purpose of data mining is to apply different data analysis methods to enormous data to discover significant rules or knowledge. By doing so, we can help enterprises get a better understanding of subjects interested and offer enterprises related knowledge when they face problems [3].

This research aims to utilize association rules analysis to discover related knowledge on subjects/problems that an enterprise greatly concerns. First of all, we have to understand the definition of association. Take an example of maintenance data, if the replacement of material B is 90% co-existed with the replacement of material A in maintenance records, the relation between them is an association[4].

We further make a more specific definition on the association rules [5]: Suppose that  $I = \{i_1, i_2, \dots, i_m\}$  is a

set of items. Let  $D$  be a set of database transactions where each transaction  $T$  contains a set of items such that  $T \subseteq I$ . Each transaction is associated with an identifier, called TID. Let  $X$  be a set of items. A transaction  $T$  is said to contain  $X$  if and only if  $X \subseteq T$ . An association rule, represented as  $X \subseteq Y$ , where  $A \subseteq I$ ,  $Y \subseteq I$ , and  $X \cap Y = \emptyset$ . The rule  $X \subseteq Y$  holds in the transaction set  $D$  with support  $s$ , where  $s$  is the percentage of transactions in  $D$  that contain  $X \subseteq Y$ . The rule  $X \subseteq Y$  has confidence  $c$  in the transaction set  $D$  if  $c$  is the percentage of transactions in  $D$ , containing  $X$ , that also contain  $Y$ .

Association rules mining algorithms such as Apriori [5] generally begin with single items and then join frequent single items to obtain multiple item sets. The method of Apriori requires a lot of times of scanning on the database, thus a great amount of time and space are required. This research adopts CIT algorithm [6], which only requires a scan on database at the beginning of the mining process, and thereafter association rules can be generated based on the constructed index tree.

Though we could thoroughly unearth numbers of association rules by data mining methods, it's uneasy to determine which are constructive association rules by algorithms. Therefore, the key technology lies on how to produce association rules and determine constructive and meaningful rules to avoid worthless effort on meaningless association rules [7]. Determining whether an association rule is constructive may reply on more than a single criterion, and the criteria vary with domain areas too. To consider multiple criteria simultaneously, a multi-criteria decision making (MCDM) method [8] is needed, of which utility theory is an effective method when the decision makers' preferences are under consideration [9].

### 3. Proposed Framework for Enterprise Knowledge Discovery from Databases Using Data Mining

This research proposes a framework for enterprise knowledge discovery, which features on practical and systematical data mining procedure and extracting important and meaningful knowledge from the numerous mined association rules. The framework contains two stages. The first stage is to look into an enterprise's processes where the subject areas the decision makers feel interested or the problems had occurred. By mapping the tasks of the selected processes to the corresponding attributes of the database tables, data mining tasks can be defined and conducted. The second stage is the multi-criteria assessment on the results analyzed and mined at the first stage in order to assure the meaningful and important knowledge is discovered. The framework of this research is displayed in Figure1, which will be further introduced in the following sections.

#### 3.1. Search for subjects/problems

The processes of an enterprise can be searched and examined to define the interested subjects or problems. Cause-and-effect diagram (or fishbone diagram) can be used to depict the overview of an enterprise's main processes [10][11]. Figure 2 shows a cause-and-effect diagram for the main management processes of a manufacture enterprise.

In constructing the diagram, main management processes have to be identified first, and the corresponding sub-processes for each main management process are listed next.

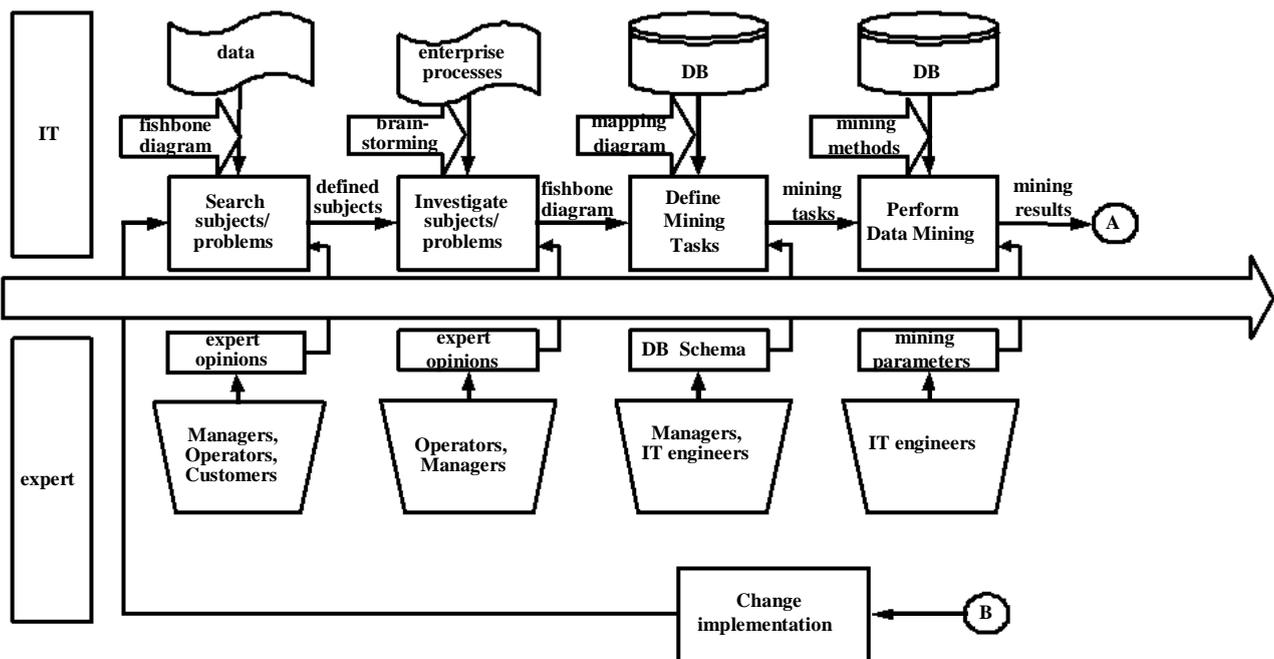


Figure1. A proposed framework for enterprise knowledge discovery from databases using data mining

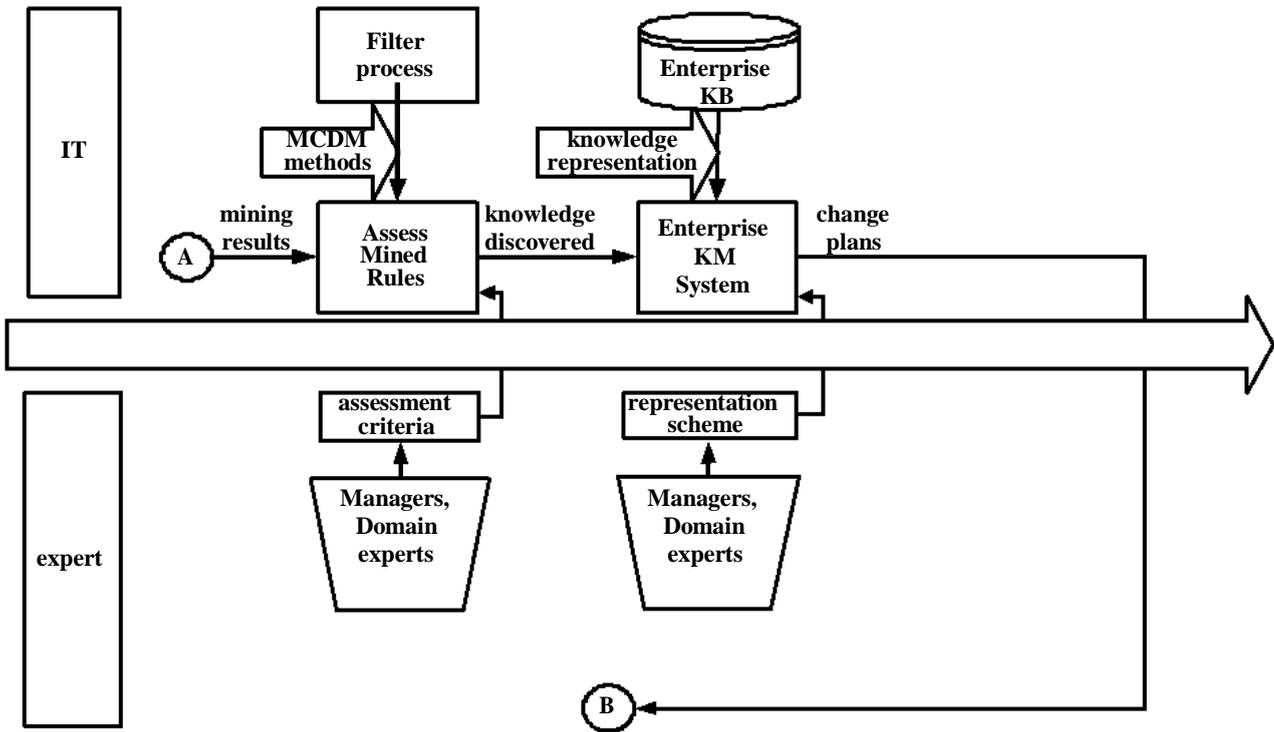


Figure1. A proposed framework for enterprise knowledge discovery from databases using data mining (Cont.)

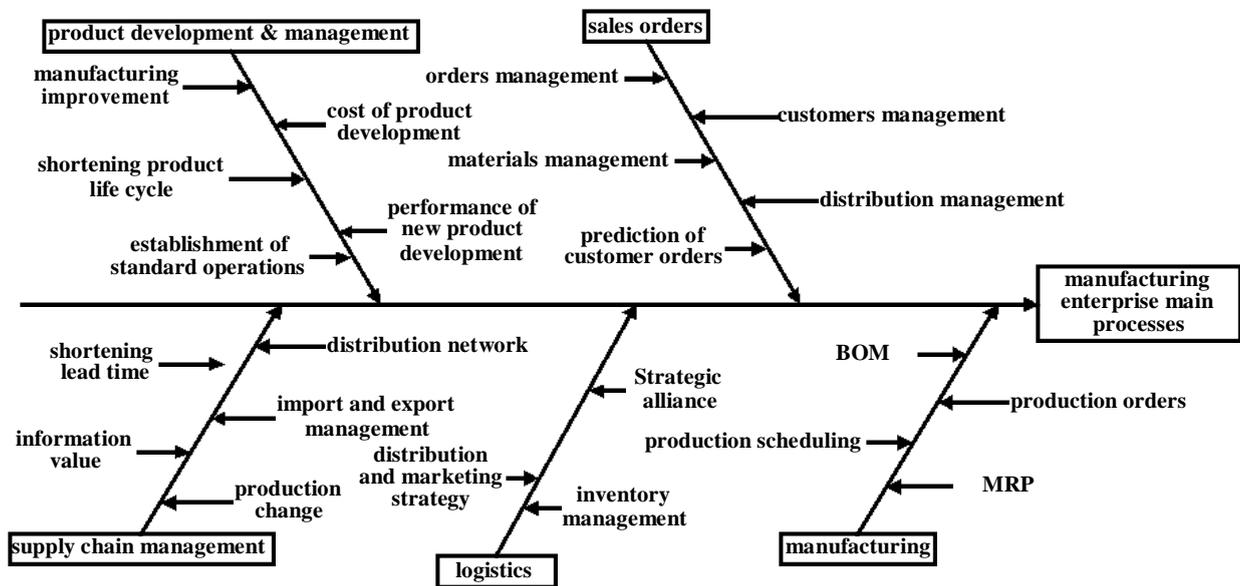


Figure 2. A cause-and-effect diagram for enterprise main functions

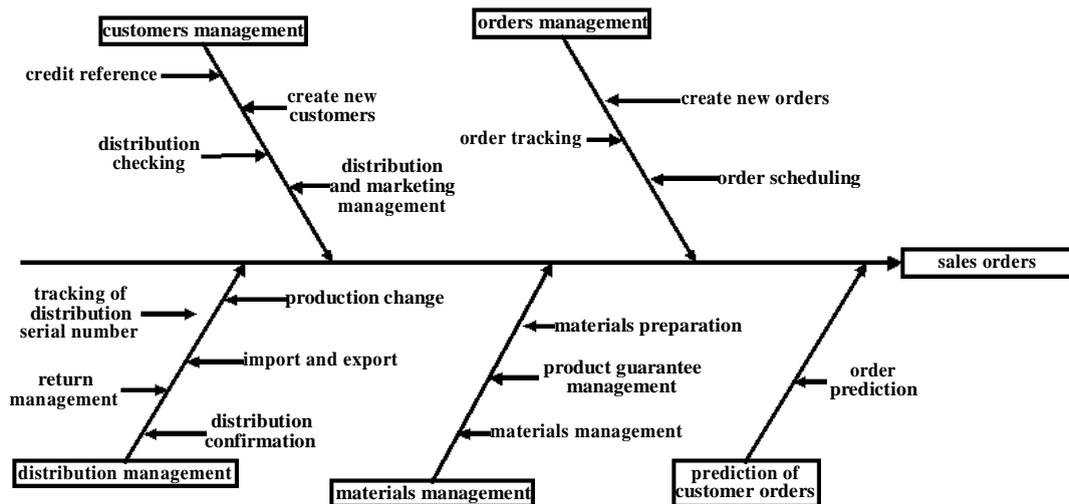


Figure 3. A cause-and-effect diagram for customer orders

The sub-processes can be further decomposed into sub-processes at a more detailed level. The cause-and-effect diagram of sales orders in Figure 2 is shown in Figure 3. Similarly other main processes can be decomposed and depicted as separate cause-and-effect diagrams at a more detailed level. With the processes of an enterprise depicted using cause-and-effect diagrams in detail at different levels, the interested subject areas or existing problems can be easily identified [12].

### 3.2. Investigate subjects/problems

After we locate the interested subjects/problems, the next step is to separate the associated processes into two parts: one that can be analyzed by data mining or the other that cannot [13]. Those processes to be mined are further investigated. Operators, managers, and domain experts all need to join the brainstorming team and opinions can be exchanged to better understand the subjects/problems, and finally the directions of data mining tasks can begin to take shape.

### 3.3. Define mining tasks

The function of Data Mining is to discover all kinds of hidden patterns from the data set. The purpose of this step is to search for the data for mining that are related to the target enterprise subjects/problems. Therefore, as defined in prior sections, the selected enterprise processes are compared with the attributes in the database. Finally compose a *tasks and attributes correspondence diagram* for Data Mining [14]. Figure 4 is an example of tasks and attributes correspondence diagrams. The diagram corresponds the enterprise processes interested, from managerial perspective, to the attributes in the databases, from data mining perspective. According to the tasks and attributes correspondence diagram, data mining tasks can be defined to discovery knowledge related to the selected enterprise processes from the databases. Before data mining is performed, data has to be preprocessed. Data preprocessing generally includes the following steps:

1. Conceive the data source and commence data collection
2. Acquire related knowledge and technology
3. Integrate and check data
4. Remove false or inconsistent data

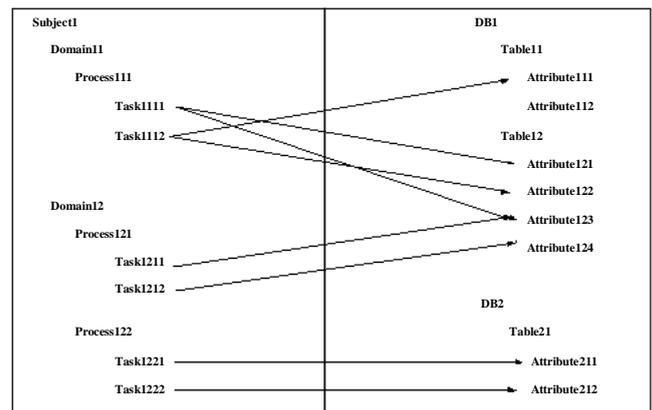


Figure 4. A tasks and attributes correspondence diagram

### 3.4. Data mining

By the progress of information technology and the entering of electronic business era, enterprises have already focused on making the best use of databases to acquire useful information or knowledge rather than only collecting and storing data. It becomes increasingly important nowadays for enterprises to effectively acquire data mining tools for database data mining when competing with competitors. Figure 5 displays the data mining project for enterprise knowledge discovery.

The feature of data mining is to search for meaningful patterns from giant databases. It acquires meaningful patterns from databases and transforms them into information or knowledge for supporting enterprise decision making. Different kinds of technologies, such as Genetic Algorithms, Neural Networks, Fuzzy Logic, Case-Based Reasoning, etc., could be used for data

mining. This research adopts an association rules mining algorithm, CIT Algorithm [6] to look for possible results. The advantage of it is that CIT algorithm allows for mining with causality. Take the problem of quality control for example: we could have the materials replaced for cause attribute and the malfunctioning conditions for effects to search for specific associations between replacement materials and malfunctioning types. Mined association rules may provide valuable reference information or knowledge for product research and development.

### 3.5. Assess mined rules

This step assesses patterns from the mined results according to the predefined criteria and unimportant or minor association rules will be ignored. To effectively determine the assessment criteria, this research proposes a concept which lays emphasis both on objective and subjective factors in the process of filtering. There are two basic elements in the process of assessment: feasible alternatives and decision-making criteria. Criteria either objective or subjective, taking quality issue for example, such as the cost of processing, the effect on goodwill, the improvement on productivity, the violation on policies, and the decrease in the number of service can be applied based on the criteria importance and decision maker's judgment.

Since multiple criteria are being considered in assessing the mined association rules, weighted sum model (WSM) is used to formulate the assessment equation:

$$Rule\_imp(j) = \sum_{i=1}^m w_i * x_i, \text{ for } i = 1, 2, \dots, m.$$

where

$Rule\_imp(j)$  is the importance value for rule  $j$ ,

$x_i$  is performance value for criterion  $i$ ,

$w_i$  is the weight for criterion  $i$ , and

$m$  is the total number of criteria considered.

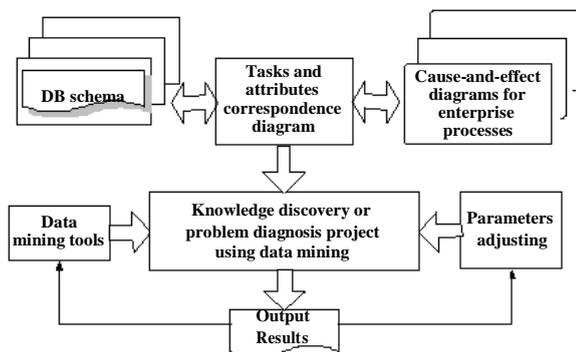


Figure 5. Data mining project

### 3.6. Enterprise knowledge base

Personal know-how through knowledge acquisition process and knowledge discovery using information technology both contribute to the creation of enterprise

knowledge base. When decision makers are dealing with semi-structured or unstructured problems, enterprise knowledge base can be referenced to improve the quality of enterprise decision making. To make the knowledge acquired accessed and shared, an enterprise knowledge management system is needed. Besides, knowledge representation scheme is necessary for systematically storing the acquired knowledge. The associated managers and operators to improve the current performance or to solve the problem can reference the discovered knowledge related to the selected subjects/problems. If the mining results cannot satisfy the associated personnel, the whole knowledge discovery process needs to be initiated all over again. If the knowledge discovered provides insight in solving the problem or improving performance, the resulting change plan then can be implemented, and it ends the knowledge discovery process.

## 4. A Case Study on the Quality Improvement in a Manufacturing Company

The proposed knowledge discovery framework and the associated methodology were applied to quality improvement on product design in a manufacturing company. In product development, it will be, however, a Herculean task for the R&D center to reassemble parts and test to find all the defective items provided by the manufacturing bases located world wide. Usually the purpose of these tests is only to locate the incompatibility among some electronic items to reduce the occurrence of uncertain operational breakdowns after the goods left the factory.

Owing to the numerous combinations in product items, how to prevent this kind of problems from happening again and again has always been a tough task for industries in analyzing the maintenance data. The burden of analyzing the incompatibility among electronic items is always untaken by experienced experts. This kind of approach is however time-consuming yet ineffective. In fact, the industry already has established a database and a complete collection of all detailed maintenance data from service centers world wide. We should be able to make good use of the database, accumulated for years, for analysis and data mining.

The proposed methodology was applied to the R&D problem. A cause-and-effect diagram was generated as shown in Figure 6.

Next we constructed the tasks and attributes correspondence diagrams and defined the association rules mining tasks. CIT algorithm was applied to more than twenty thousand real maintenance records of products being returned for service due to malfunctioning with six attributes from two database tables. We employed different values of *minimum confidence* and *minimum support* and obtained different number of association rules as shown in Table 1.

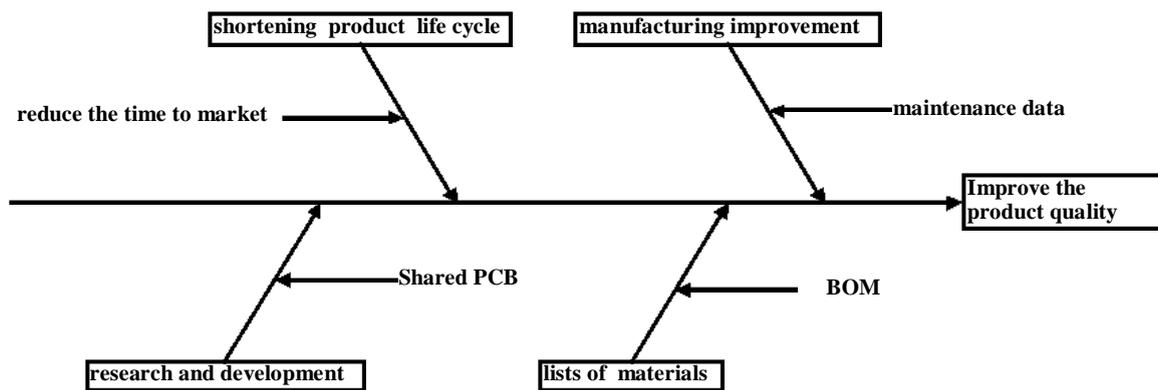


Figure 6. A cause-and-effect diagram for improvement of product quality

Table 1. Numbers of association rules extracted using CIT algorithm for different values of support and confidence

Support \ Confidence	5	10	20	50
99%	376531	40566	2288	58
80%	505550	43767	2878	58
50%	515960	48907	2878	93

The association rules generated from maintenance records as in Table 1 contain a great deal of meaningless association rules. After eliminating these meaningless ones, we can better understand the quality problems due to defective parts or incompatibility in the assemblies. Defining the rules of eliminating meaningless association rules requires domain knowledge about maintenance and design processes and three rules are shown below:

- Rule 1 For an association rule “items A and B together cause the failure of item C,” if the confidence of the rule is not 100%, it will be eliminated. This is to make sure defective items A and B simultaneously do relate to the failure of item C.
- Rule 2 Only defective electronic parts are considered in discovering knowledge about incompatibility problems. If the defective parts contain non-electronic items, the rules are eliminated.
- Rule 3 By checking with the BOM structures, if different electronic items from different products are found in an association rule, it will be eliminated. This is because the incompatibility problem only considers items on the same product.

In the data mining process, for the circumstance of the *minimum confidence* set to be 99.9% and the *minimum support* set to be 10, 40566 association rules were acquired. 2788 association rules were left after elimination based on rules 1 and 2. Finally, 82 crucial association rules were obtained when the third elimination rule was performed. Some of the final

association rules are listed in Table 2.

The 82 eventually gained association rules were assessed in terms of five criteria and assigned with separate weights. Five criteria cost, goodwill, productivity, policy, and service are assigned with weights of 30%, 30%, 20%, 10%, and 10%, respectively. Cost criterion refers to direct and indirect costs spent related to the service; reputation refers to the level of enterprise’s reputation was affected due to malfunctioning types; productivity refers the level of enterprise’s productivity can be improved by redesign; policy means importance from the perspective of enterprise’s policies from decision makers (e.g. the phased out models will not be processed); and service indicates the times of services required can be reduced after redesign.

Table 2. Examples of association found by data mining on incompatibility problem

Part ID	Part ID	Part ID	=>	Related Part ID
BA015J1	BP022A4	BY400B0	=>	BA015J1
BC176G0	BL003W0	BN012A5	=>	BC176G0
...				

In terms of these 5 criteria, we used weighted sum model (WSM) to calculate the rule importance for each association rule. The importance can be regarded as the priority for each association rule. Some of the results are shown in Table 3.

After testing and verifying the proposed framework on enterprise knowledge discovery on quality problem, it is found that the mined association rules provide frequent associations of multiple electronic items occurring on the same products being serviced. These rules may provide interesting and valuable information in product research and development, they can also be provided for inspection of a new model design to reduce the possibility of the same failure to happen again.

**Table 3. Rules importances calculated for mined association rules**

Part ID	Part ID	Part ID	=>	Related Part ID	Rule importance
BA015J1	BY400B0		=>	BP022A4	2
BA015J1	BY400B0	BY809B0	=>	BP022A4	1
BP022A4	BY400B0	BY809B0	=>	BA015J1	3
BU002S5	BN012A5		=>	BR008B5	5
BR008B5	BU002S5		=>	BN012A5	7
BR008B5	CR107C0		=>	BN012A5	6
RR229F	TP156Z0	RR229F1	=>	BN012A5	4
...					

## 5. Conclusions

This research has proposed a practical framework for enterprise knowledge discovery using data mining. The six steps of the framework are described in detail along with associated techniques or methods. By cause-and-effect diagrams, the processes of an enterprise can be modeled and analyzed. With tasks and attributes correspondence diagram, data mining tasks can be defined. Collect the right data from the enterprise database, then proceed data mining to discover the association rules relevant to the subjects/problems selected. In the case study, we extracted relevant association rules to incompatibility issue out of more than 20,000 maintenance records. After filtering process, fewer significant and more meaningful association rules are left. With multi-criteria decision making method, the rule importance can be calculated for each association rule. The association rules then can be referenced based on the rule importance. The association rules discovered have been found very useful in improving the product design and to reduce the failure in products due to incompatibility. This proposed framework that integrates multiple techniques provides a very practical approach and guidance for practitioners in knowledge discovery and problem solving. The case study also demonstrated the applicability of the framework in the industry.

## References

- [1] Saxena, K.B.C. and Sahay, B.S., "Managing IT for world-class manufacturing: the Indian scenario," *International Journal of Information Management*, Vol.20, No.1, pp. 29-59, 2000.
- [2] Deslandres, V. and Pierreval, H., "Knowledge acquisition issues in the design of decision support systems in quality control," *European Journal of Operational Research*, Vol.103, No.1, pp. 296-311, 1997.
- [3] Lin, F. Y. and McClean, S., "A data mining approach to the prediction of corporate failure," *Knowledge-Based System*, Vol.14, Nos.3-4, pp.189-195, 2001.
- [4] Dabbas, R. M. and Chen, H.-N., "Mining semiconductor manufacturing data for productivity improvement – an integrated relational database approach," *Computers in Industry*, Vol. 45, No.1, pp.29-44, 2001.
- [5] Han, J. and Kamber, M., *Data mining: concepts and techniques*, Morgan Kaufmann Publishers, Academic Press, 2001.
- [6] Changchien, S.W. and Lu, T.C., "Mining Association Rules from Databases Using Class Inheritance Tree (CIT)," submitted for publication in *Data and Knowledge Engineering*.
- [7] Guillaume, S. and Charnomordic, B., "Knowledge discovery for control purposes in food industry databases," *Fuzzy Sets and Systems*, Vol.122, No.3, pp.487-497, 2001.
- [8] Triantaphyllou, E., *Multi-Criteria Decision Making Methods: A Comparative Study*, Kluwer Academic Publishers, 2000.
- [9] Hatush, Z. and Skitmore, M., "Contractor Selection Using Multi-criteria Utility Theory: An Additive Model," *Building and Environment*, Vol.33, Nos.2-3, pp.105-115, 1998.
- [10] Tseng, H. C., Ip, W.H. and Ng, K.C., "A model for an integrated manufacturing system implementation in China: a case study," *Journal of Engineering and Technology Management*, Vol.16, No.1, pp.83-101, 1999.
- [11] Wu, B. and Ellis, R., "Manufacturing strategy analysis and manufacturing information system design: Process and application," *International Journal Production Economics*, Vol.65, No.1, pp.55-72, 2000.
- [12] Coronado, M., Adrian, E., Sarhadi, M. & Millar, C. "Defining a framework for information systems requirements for agile manufacturing," *International Journal Production Economics*, Vol.75, Nos.1-2, pp.57-68, 2002.
- [13] Gillenwater, E., Conlon, S. and Hwang, C., "Distributing Manufacturing Support System: the Integration of Distributed Group Support System with Manufacturing Support System," *Omega*, Vol.23, No.6, pp.653-665, 1995.
- [14] Tsechansky, M. S., Pliskin, N., Rabinowitz, G. and Porath, A., "Mining relational patterns from multiple relational tables," *Decision Support Systems*, Vol.27, Nos.1-2, pp.177-195 1999.

# The Feasibility and Method of News Mass Customization (NMC)

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## Abstract

Mass Customization (MC) is a new production mode developed from the combination of Mass Production (MP) and single customization. News businesses putting the News Mass Customization (NMC) in force has its inherent advantages and NMC is a new way to get competence. The paper firstly analyzes two problems—notation of MC and NewsML which have strong relation with NMC. Secondly, Compared with the MC rules in manufacturing industry, we draw the feasibility of NMC in News Businesses. Finally, according to the usage of Petri nets, we describe the NMC process and provide a detailed implement method.

Keywords: News Mass Customization (NMC); NewsML; Personalized News

## 1. Introduction

With the rapid development of society and civilization, the post-industrial era characterized by information technology (IT) and cybernation [4] is coming. While the traditional industrial economics has been replaced by knowledge economics, the useful information has been noted as a new and rare resource. At the same time, with the development of Internet, the emergence of all kinds of Websites like the bamboo shoots in the spring rain, and the electric commerce is gradually recognized as a new model of transaction. Any coin has two sides, we are now locating at a situation that we can not get the rapid and exact information even if the total number is enormous, as the saying goes “Rich data, Poor information”. How to provide the exact information for special customers is always to make the researches confused [1][2].

The word of Mass Customization (MC) stems from

the manufacturing industry, its core is to provide the personalized and customized products or/and services for customers with low cost and high efficiency of Mass Production (MP)[3][4]. On one hand, in the fields of news, the number of documents in database of news media is becoming more and more enormous, and the volume of the data is increasing exponentially. The news issuing and transmitting format is complex, the incompatibility is exist between them as well. On the other hand, while it is becoming more critical for customers to the news quality, the traditional standard has been replaced by a new mode which has open, interfacing, free and equal properties. The news with normalized, varied and personalized attributes is the tendency, and a new technology criteria as the basic platform is needed which can organize and issue colossal news information.

## 2. The notation of MC and the criteria of news—NewsML

Changing market, global competition and customized demand are severely challenging the traditional production modes. There are two elementary modes—Mass Production and single customization in recent years. The MP can provide the monotony product with low costing and high efficiency while single customization provides variable handmade products with high costing and low efficiency. Both of them have their merits and defects. Getting an efficient production mode is a seeking object for businesses to combine their merits and discard their defects. In the past decades, with the development of network and computers and the emergency of management modes such as Concurrent Engineering (CE), Supply Chain Management (SCM) and Customer Relationship Management (CRM), it is possible

that business produce customized production with the costing and efficiency of Mass Production (MP). In 1992, the master piece *Mass Customization: the New Frontier in Business Competition* [3] by an American scholar B. Joseph Pine II symbolizes the birthday of MC theory.

MC is that businesses use advanced technology such as Computer Aided Technology (CAD/ CAM/ CAPP), Flexible Manufacturing System(FMS), Group technique(GT) and advanced management modes such as CE,SCM,Business Process Reengineering (BPR) and CRM. to provide customized products and/or services for customers and put all or partial product process reengineering in force to produce products which costing and efficiency is the same or similar to that of MP[3][4][5]

Generally, Mass Customization has the following attributes:

(1) MC is a push/pull mixed production mode oriented to customers' demand.

(2) MC is a kind of Agile manufacturing mode to improve the adaptive ability of environment.

(3) MC emphasizes the customization in different levels. The similarity to the variety strategy is to satisfy the personalized demands.

(4) On the base of the standard, reasonable and generalized parts, MC tries to design modularized product so as to provide cheap and customized product in rapid speed.

(5) MC design is divided into new product development and distorted design. They have the sequent relation. The first part is to satisfy the low costing and the second is to satisfy the customized demands.

(6) MC emphasizes the support of IT and flexible manufacturing technology.

From the point of notation of MC, if a news business wants to provide NMC for customers, it must have a new technology criteria to organize and issue colossal news information. International Press Telecommunications Council (IPTC) issued a news logo language (NewsML version 1.0) in October, 2000. It gives a new lease to news sharing and issuing, and it is important for news businesses to satisfy customized demands.

NewsML is not only a terse, extensible and flexible standard as a news treatment framework, but also a

format standard for the uniform description, package, storage and transmission of media news [1]. It is convenient for computer to handle. The news with different contents supplier can be shared and exchanged on the base of it.

In sum [2], NewsML document always has three parts, DTD or Schema for defining the NewsML document logic structure, XSL for defining NewsML document display format and News document file which is written according to the DTD or schema .In addition, DTD(Document Type Definition) is a new series of syntax rules for news information marker sign. It defines the element contained, element attributes and relationship among these elements .XSL(extensible Stylesheet Language) is responsible for the display format of document in user's look through terminals. Different format of the same news are displayed with different stylesheet . NewsML document file is the main of NewsML document which refers to the file contents on the base of DTD or schema [7][8].

### 3.The feasibility of NMC

In the fields of news businesses, news is its products .The concerning and valuable customized news maybe regarded as a type of MC. From the analyzed attributes of MC, NMC also has these related attributes.

News occurs at all the time and the number is enormous. When a reader prints concerned keywords, network may arrange the related news from enormous databases to meet the reader's requirement.

A good Websites and corresponding news institution must focus on the social situations and issue the messages and policies to readers in time, so we must issue news with agile model.

While news contents are varied and can be classified, readers may look through interested news, at the same time, almost all the news agencies issue concerned news corresponding special events, thus embody the variety of news.

In order to get exact and valuable information and ensure the issued channel straightaway, we must get the rapid transmitted measure by using the standard, reasonable and generalized issue format.

In manufacturing fields, the design process of MC

has two stages. And maybe there are two stages in NMC. For example, a news group may have several kinds of newspaper, the core content concerned with domestic and foreign may be similar, but in order to reflect respective characteristic of different newspaper, the exact content is different.

The news issuing is supported by computer and IT in itself, the intention of flexible manufacturing is to manufacture customized products and/or services in rapid speed. While news itself needs to record the occurred and occurring matters, the flexibility totally depends on the reporters and the editors' ability

Although there are several successful cases with MC in foreign such as DELL computer corporation, Motorola corporation and Anderson door and window corporation. Seldom businesses take the MC in our country. The essential reason is that our business can not implement the three steps as a seamless whole from product specification to product logistics [6].

(1)Elicitation: a mechanism for interacting with the customer and obtaining specific information

(2)Process: flexibility: production technology that manufacture the product according to the information.

(3)logistics: subsequent processing stages and distribution that are able to maintain the identity of each item and to deliver the right one to the right customer

Generally speaking, the customers are often amazed at deciding what they want. They are easily overwhelmed by too many selections on a store shelf or a Web page. Business may make use of identification, customers' selections from menus of alternative, physical measurements and reactions to prototypes to complete, but all these measures are expensive in China. In news fields, business may list a questionnaire through network, customer may leave names and preference, and then use the special database to store them, and either customer or business itself may accept the method.

As for the flexible manufacturing, businesses must put into much of human, material and financial resources for the advanced equipment characterized computer and network communication. The situation is not prevailing even abroad. Because of the peculiarity of product in news fields, news business may not invest these expensive equipments and only depends on the human and network

intelligence to provide news for customers.

After the product is manufactured with customers' specific information, here may be several additional processing and transportation tasks. It is not easy to transport the special products to special customer, it depends on the developed logistic system. But for the news business, it is easy to achieve, It may use network to fulfill them without any waste of human, material and financial resource. Customer may open his own mailbox to get the special products.

According the analysis mentioned above, we may conclude that it is feasible to accomplish NMC in news business.

#### **4.NMC process description based on Petri nets[9][10]**

. As mentioned above, we emphasize that NewsML is a general platform for news issuing and sharing, NMC process is the application of the NewsML.

In the full description, we take Petri nets as a tool. Place means information status represented by circle. Transition means the handling of concerned data represented by box.

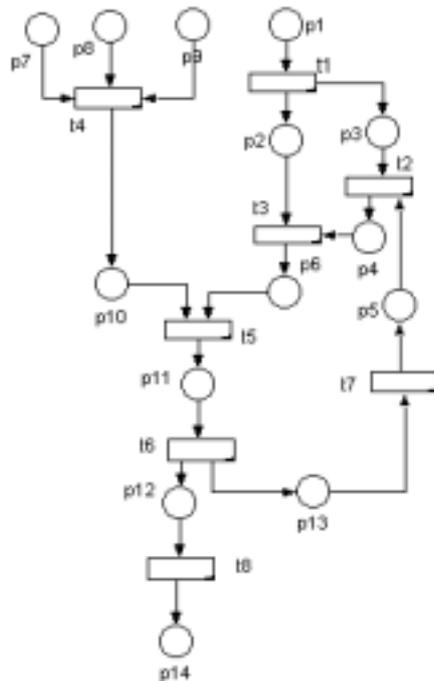
As Fig.1 shows, the NMC process mainly contains three components, requirement interface process, information integrated process and data mining and issuing process. Place p5 is the customers' database recording customers' characteristic, when customer print keywords, we may analyze customers' characteristic according to the keywords and the special database. After getting the required information, we renew and store new records. Places p7, p8, p9 are the representatives of all kinds of databases, news business integrate these databases by an agent mechanism and get the integrated information which provides operation objects for data mining. According the mined data, we divide them into two parts and store in places p12 and place p13.

#### **5.Conclusions**

NMC is a new way for news businesses to provide top-quality and customized news for readers. It can win competency and customers' appeal. Based on the market situation and news issuing and sharing faults, we firstly analyzed notation of MC and NewsML, which are

strongly related to NMC, and explained the attributes of MC in manufacturing industry and the attributes and components of NewsML as well. Secondly, the feasibility of NMC is analyzed by the comparison of news businesses and manufacturing ones. At last, we use Petri nets as a tool to describe the NMC process based on the NewsML, as figure 1 shows that the combined measure is

taken of requirement characteristic and data mining. And agent mechanism is used to integrate all kinds of database and then provide customized news for customers. As we know the concept of NMC is proposed as a new thing, there is still a long way to go. In this paper we just explored the feasibility and method in theory, the full application is to be studied in the future.



**Fig.1 NMC process description based on Petri nets**

**Table 1 The notation of places and transitions**

p1	customer's request	p12	mined information satisfied with customers
p2	wanted keywords	p13	new characteristic of customers
p3	customer data	p14	information sent to customers
p4	customer characteristic,	t1	input requirement
p5	customer database	t2	analyze customer's characteristic
p6	information satisfied with customers' requirement	t3	analyze information
p7	DataBase A	t4	integrate DataBase
p8	DataBase B	t5	data mining based on DataBase
p9	DataBase C	t6	analyze mined data
p10	integrated information of Database	t7	renew customers' DataBase
p11	mined information	t8	send valuable information to customers



# Factors Influence Information and Knowledge Sharing in Organization

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## Abstract

In today's business environment, competitive advantage increasingly requires the open sharing of knowledge by organizational members [22]. Although the practitioners place emphasis on the importance of knowledge sharing, empirical researches on knowledge sharing are still limited, and little research has been done to understand the factors that influence knowledge sharing in organizations. This study investigates cultural and interpersonal factors that influence an individual's propensity to share information and knowledge that he or she has created. Three different situations of sharing (information product, self-developed knowledge and organization-developed knowledge) were considered. The study found that organization culture influenced individual's beliefs of organization trust and psychological safety, and those who perceived higher trust and psychological safety seemed more likely to share information and knowledge with others.

Keyword: knowledge management, knowledge sharing, organizational culture, trust, psychological safety

## 1. Introduction

In today's business environment, competitive advantage increasingly requires the open sharing of knowledge by organizational members [17]. Drucker et al. [10] have identified harnessing "the intelligence and spirit of people at all levels of an organization to continually build and share knowledge" as a top priority for firms wishing to succeed in today's competitive environment. However, the efforts of many companies to manage knowledge have not achieved their objectives.

David and Liam [9] revealed that organizational culture is widely held to be the major barrier to creating and leveraging knowledge assets. Organizational culture creates the context for social interaction and forms individuals' beliefs about interpersonal relationships. Organizational research has emphasized cognitive and interpersonal factors to explain effectiveness, showing that individuals' tacit beliefs about interpersonal interaction inhibit learning behavior and give rise to ineffectiveness in organizations [1]. However, the role of beliefs about the interpersonal context in individuals' willingness to share information and knowledge under threatening or trusting psychological state has been largely unexamined.

Although the practitioners place emphasis on the importance of knowledge sharing, empirical researches on

knowledge sharing are still limited, and little research has been done to understand the factors that influence knowledge sharing in organizations. Many researches have relied on qualitative studies that provide rich detail about cognitive and interpersonal processes, but do not allow explicit hypotheses testing. This paper presents a model of knowledge sharing and tests it with a survey method. This objective of study was to investigate whether culture and beliefs about the interpersonal context influence the propensity of employee to share information and knowledge.

## 2. Theoretical Background

Constant et al. [5] advanced a theory of information sharing to understand the factors that support or constrain information sharing in technologically advanced organizations. The theory goes beyond communication and information exchanges among friends and personal contacts to include "organizationally-remote strangers they will never meet in person". Their theory consists both organizational contextual factors and psychological factors including feelings, values, and self-identities. They use this model to explain why people are or are not sharing their best information and knowledge, regardless of the financial incentive, organizational mandate, and amount of technology.

The Constant et al. [5] theory of information sharing roots in social exchange theory. Social exchange theory provides a complementary perspective to the economic exchange perspectives. Sharing Information and knowledge as social exchanges are similar to economic exchanges in the concept that there is an expectation of what will return exactly. Kim and Mauborgne [15] and Culnan and Armstrong [6] argue that rules of social exchange govern knowledge sharing. Individuals participate in social exchanges to maintain future relationships, the balance of power, and image. Organizational culture creates the context for social interaction and forms individuals' beliefs about interpersonal relationships [9]. When people embedded in the same culture examine values and norms in that system, the result can affect individuals' beliefs of interpersonal relationships and psychological safety and may in turn influence information and knowledge sharing behavior.

### 3. Construct definition and Hypotheses

#### 3.1 Propensity to share information and knowledge

Propensity to share information and knowledge is part of attitudes toward pro-social organizational behaviors (Jarvenpaa and Staples, 2001). The pro-social attitudes capture the general tendency of people wishing for good outcomes not only for themselves, but also for other employees or the organization [3]. Acts like helping, sharing, and volunteering are aimed at maintaining the well-being and integrity of others and the self, and are not directly or explicitly rewarded, but contribute positively to the organization's performance.

Barnes [2] notes "An individual possesses power by being a referent in a distribution of knowledge." When people share what they know with other people, they have lost ownership of knowledge they alone had previously controlled. So individual have good reasons not to share what they know. Knowledge is used at the individual level for both control and defense.

#### 3.2 Organizational Culture

Organizational culture refers to the shared values and attitudes of the members of an organization. Organizational culture has long been argued to affect the consequences of knowledge sharing. Dialogue between individuals or groups are often the basis for the creation new ideas and can therefore be viewed as having the potential for creating knowledge. Culture may encourage/discourage knowledge sharing behavior in organization. For example, Orlikowski [18] found that "in competitive and individualistic organizational cultures-where there were few incentives or norms for cooperating or sharing expertise- groupware did not engender collaboration."

When people embedded in the same culture examine values and norms that shape behavior in that system, the result can increase (or decrease) trust. Good inter-personal relationships, and open communications are continually identified by case studies to be critical in maintaining trust, thus we hypothesize:

H1: Organizational culture is positively associated with an individual's trust

Psychological safety is defined as belief that an individual is safe for interpersonal risk taking. Mutual face saving thus makes normal social relations possible. But in that very process we operate by cultural rules that undermine valid communication and create what Argyris[1] calls "defensive routines." To be polite, to protect everyone's face, especially our own, we tend to say what we feel is most appropriate and least hurtful. It becomes cultural rule to "say something nice if you say anything at all, and if you can't say something nice, don't say anything." Thus we hypothesize:

H2: Organizational culture is positively associated with an individual's psychological safety.

#### 3.3 Trust

Trust, defined as reciprocal faith in others' intentions and behavior, has been identified as integral not only to the performance of small teams, but also to many current organizational arrangement. Trust is an expectation that alleviates the fear that one's exchange partner will act opportunistically. The attainment of trust leads to knowledge sharing behavior. A study of the relationship between marketing research providers and users, shows that trust is a facilitating factor of other relationship processes such as quality of interactions and involvement levels. By alleviating the fear of the unexpected and facilitating interactions and involvement, trust encourages a climate conducive to the sharing of knowledge.

March and Olsen(1990) suggest that trust facilitates learning between partners and that decisions to exchange in knowledge under certain conditions are based on trust. Without trust people assume self-protective, defensive postures that inhibit learning [19]. An atmosphere lacking in trust leads to the withholding of information and can be harmful to the processes of knowledge articulation, internalization, and reflection.

We expect the individual's organizational trust to affect their propensity to share information and knowledge with other colleagues in organization. Thus we hypothesize:

H3: Trust is positively associated with an individual's propensity to share information and knowledge.

#### 3.4 Psychological Safety

Psychological safety is defined as belief that an individual is safe for interpersonal risk taking. Lipshitz, Popper and Friedman (1999) defined psychological safety as "a state in which people feel safe in honestly discussing their mistakes and what they think, and how they feel." For the most part, the belief tends to be tacit- taken for granted and not given direct attention by the other individuals. The construct has roots in early research on organizational change, in which Schein and Bennis (1965) discussed the need to create psychological safety for individuals if they are to feel secure and capable of changing. Schein (1993) noted that learning new habits and skills sometimes involves unlearning, which is emotionally difficult, and making mistakes, which raises anxiety owing to feelings of incompetence. Thus, people are more likely to act transparently, and to investigate their own mistakes with integrity when they are psychologically safe than under threat. The term is meant to suggest neither a careless sense of permissiveness, nor an unrelentingly positive affect but, rather, a sense of confidence that the other members in the organization will not embarrass, reject, or punish someone for speaking up.

The importance of trust in organizations has long

been noted by researchers. Trust is defined as the expectation that others' future actions will be favorable to one's interest, such that one is willing to be vulnerable to those actions. Team psychological safety goes beyond interpersonal trust; it describes a climate that "people are comfortable being themselves." [11]

Employee tend not to share the unique knowledge they hold, such that discussion in organization consist primarily of jointly held information, posing a dilemma for sharing in organizations. Those who actively share what they have may place themselves at risk; for example, by admitting an error or asking for help, an individual may appear incompetent and damage his or her image. In addition, such individuals may incur more tangible costs if their actions create unfavorable impressions on people who influence decisions about promotions, raises [11]. Image costs have been explored in research on face saving, which has established that people value image and tacitly abide by expectations to save their own and others' face. Asking for help, admitting errors, and seeking feedback exemplify the kinds of behaviors hat pose a threat to face, and thus people in organizations are often reluctant to disclose their errors or are unwilling to ask for help. Even when doing so would provide benefits the organizations. Similarly, research has shown that the sense of threat evoked in organizations by discussing problems limits individuals willingness to engage in problem-solving activities. In sum, people tend to act in ways that inhibit sharing when they face the potential for threat for embarrassment [1].

Nonetheless, in some environments, people perceive the career and interpersonal threat as sufficiently low that they do ask for help, admit errors, and discuss problems. In hospital patient-care teams, Edmondson [11] observed that significant differences in members' beliefs about the social consequences of reporting medication errors; in some teams, members openly acknowledged them and discussed ways to avoid their recurrence; in others, members kept their knowledge of a drug error to themselves. Team members' belief about the interpersonal context in these teams could be characterized as tacit; they were automatic, taken-for-granted assessments of the "way things are around here." For example, a nurse in one team explained matter-of-factly, "Mistakes are serious, because of the

toxicity of the drugs -so you're never afraid to tell the nurse manger"; in contrast, a nurse in another team in the same hospital reported, "You get put on trial! People get blamed for mistakes... you don't want to have made one." These quotes illustrate markedly different beliefs about the interpersonal context; in the first team, members saw it as self-evident that speaking up is natural and necessary, and in the other, speaking up was viewed as a last resort. Thus, we hypothesize:

H4: Psychological safety is positively associated with an individual's propensity to share information and knowledge.

In sum we combine four hypotheses and construct the conceptual model as Figure 1.

#### 4. Method

A questionnaire-based study was conducted to test the research model. This section describes the sampling method, construct measures, and analysis methods.

##### 4.1 Sample

The college students who are on the job were selected. Every student serves in different organization with different culture and work climate. In our study, the unit of analysis was an employee in an organization.

Questionnaires were sent to 480 students in classroom. 208 students voluntarily complete the questionnaires. overall response rates of 43.3 percent were achieved. Table 1 summarizes the demographic characteristics of the respondents.

##### 4.2 Construct Measurement

To test the hypotheses, we operationalized the conceptual model as Figure 2.

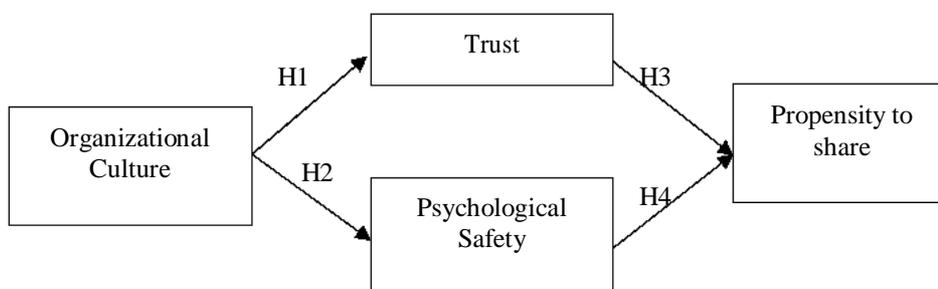


Figure 1. Conceptual Model

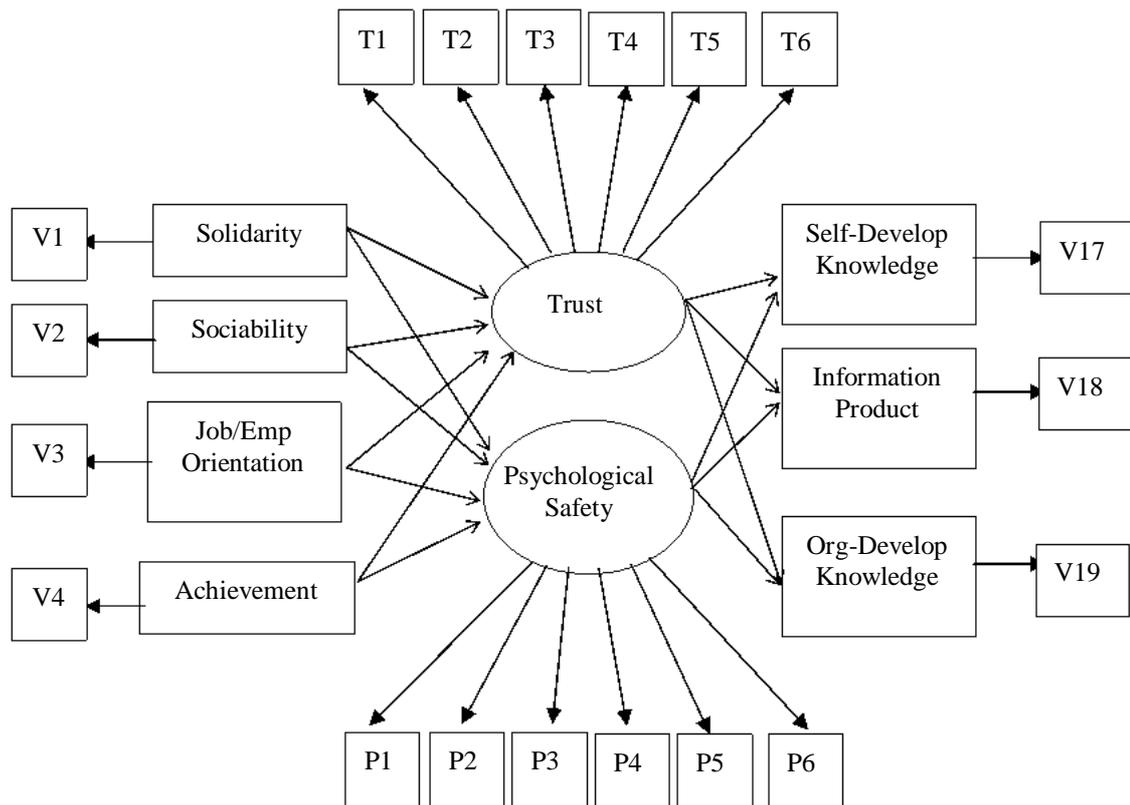


Figure 2. Research Model

The questionnaire contained multiple measurement items relating to each of the constructs in the research model. A pretest of 30 on-the-job students was carried out. Scales that had demonstrate good psychometric properties in previous studies were employed if it was possible.

Goffee and Jones [12] defined and developed measures for two dimensions of corporate culture that relate to producing and maintaining the well-being and the integrity of other coworkers as well as the organization at large- sociability and solidarity. Sociability is a measure of sincere friendliness among members of a community. Solidarity is a measure of a community's ability to pursue shared objectives quickly and effectively, regardless of social ties. Hofstede et al. [14] proposed a related dimension of employee-oriented (concern for people) versus job-oriented (concern for getting the job done). Scholz [20] identified a dimension of need for achievement. Need for achievement focuses on the importance placed in the organization on advancement and prestige.

Solidarity is associated with unarticulated and unquestioned reciprocity [12]. Sociability fosters teamwork and an environment in which individuals go beyond the requirements of their jobs to help their community succeed, Sociability is also associated with openness, which should mean fewer tendencies for individuals to want to control information and use it to build their personal power bases.

The mediators, trust was measured use Robert et al. [19] organizational trust scale. Besides the scales developed by Edmondson [11] for psychological safety, We added additional items such as "It is embarrassing to provide immature thought or advice to fellow worker."

The dependent variable, views of the propensity to share information and knowledge, was measured in 3 scenarios: sharing information products, sharing self-developed knowledge, and sharing organization-developed knowledge. The three scenarios were modified from Jarvenpaa and Staples [21]. In each of the three scenarios, a contrastive vignette technique (CVT) was used to measure the propensity to share in each of these situations. CVT is an indirect-structured methodology developed by Burstin et al. [4] to measure social attitudes. Directly to assess attitude is difficult because of the confounding effect of social desirability perceptions. Specific context are presented to respondents in short vignettes or stories. Constant et al. [5] also used this technique in their study to assess the propensity to share.

Since propensity to share is an attitude about pro-social behavior (Constant et al. 1994), this research tries to assess a pro-social attitude and not simply reciprocity and self-interest. We use Jarvenpaa's [21] vignettes describing that the individual was asked for something from a person whom had previous refused to help. In this way, we were able to capture information about the pro-social attitude.

Table 1. Sample Demographics

		Count	Percentage %
Age	20 to 29	148	71.2
	30 to 39	59	28.4
	40 to 49	1	0.5
Gender	Male	124	59.6
	Female	84	40.4
Job Title	Employee	171	82.3
	Low level manager	32	15.4
	mid/high level manager	5	2.4
Industry	Manufacturing	121	58.2
	Service	41	19.7
	Finance	10	4.8
	Others	34	16.3
Number of employee in organization	Less than 100	68	32.69
	100-200	28	13.46
	200-300	23	11.06
	300-400	14	6.73
	400-500	2	0.96
	500-1000	20	9.62
	Over 1000	53	25.48
Time in present position	Less than 1 year	50	24.04
	1-2 years	49	23.56
	2-3	33	15.87
	3-4	19	9.13
	4-5	24	11.54
	Over 5 years	33	15.87

Table 2. The Correlation matrix, Reliability of the Constructs

	1	2	3	4	5	6	7	8	9
1. Org. Culture-Solidarity	1.00								
2. Org. Culture-Sociability	0.62	1.00							
3. Org. Culture-Employee v.s. Job orientation	0.10	-0.01	1.00						
4. Org. Culture- Need for achievement	0.16	0.18	-0.34	1.00					
5. Trust	0.57	0.44	0.07	0.17	1.00				
6. Psychological Safety	0.01	-0.05	-0.27	0.25	0.01	1.00			
7. Self Developed knowledge	0.26	0.19	-0.13	0.09	0.30	0.03	1.00		
8. Information product	0.20	0.06	-0.09	0.11	0.21	0.17	0.18	1.00	
9. Org. Developed knowledge	0.25	0.08	-0.03	0.03	0.25	0.02	0.27	0.50	1.00
No. Items	4	4	4	3	6	6	2	2	2
Mean	4.44	4.63	2.96	4.96	3.88	2.60	4.68	3.38	4.01
Std. Deviation	1.30	1.05	1.19	1.19	1.28	1.09	1.22	1.48	1.37
CronBach $\alpha$	0.8340	0.7009	0.7050	0.7904	0.8905	0.7654	0.7569	0.7422	0.7050
N	208								

## 5. Analysis

The research depicted in Figure 2 was test using structural equation model. EQS statistical packages was used to simultaneously (a) create the theoretical latent variables from observed variables using confirmatory factor analysis and (b) generate estimates of the relationships among the constructs using path analysis. Testing a multivariate model using analysis of structural

The test of the hypothesized model indicated an moderate fit of the model to the data:  $\chi^2(141, N=208)=230.965, p<0.001$ . Non-significant chi-square indicates no significant difference between a hypothesized model and observed data. However, because the chi-square statistic is affected by sample size and some assumptions regarding the statistic may be invalid (Bentley, 1990), other indexes

relationships offers a number of advantages. The researcher is able to estimate direct and indirect effects simultaneously. Also, each path coefficient is estimated after the effects of all other paths have been taken into account. Table 2 reports the number of items used to measurement each construct, the reliability of the items, and the correlation matrix among the constructs.

## 5. Result

Goodness of fit were examined in this study. CFI=0.933; IFI=0.935; GFI=0.899; AGFI=0.864; Standardized RMSR=0.057; RMSEA=0.056. The standardized solution is depicted in Figure 3. Overall, the predictor variables accounted for 16.83%, 9.94%, and 11.08% of the variance in dependant variables respectively.

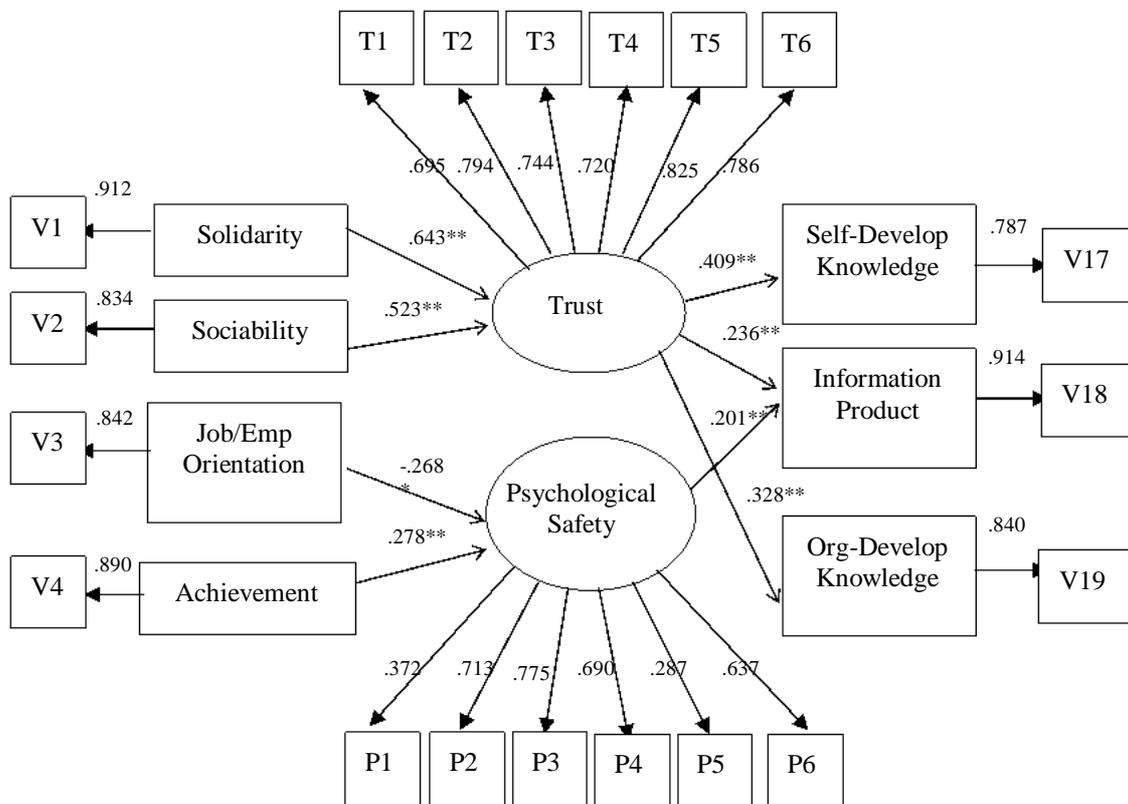


Figure 3. Standardized solution for propensity to knowledge sharing

Table 3. Variance explained in research model

Endogenous variable	Trust	Psychological Safety	Self-Develop Knowledge	Information Product	Org-Develop Knowledge
Variance explained ( $R^2$ )	69.20%	14.99%	16.83%	9.94%	11.08%

## 6. Discussion and Conclusion

Many scholars in knowledge management emphasize the employee control of information and knowledge and the importance of creating a situation that renders the employee willing to share voluntarily. Davenport [7] distinguished information sharing from involuntary information reporting. Information sharing is a “voluntary act of making information available to others...sharer could pass information on, but doesn't have to” [8]. Kim and Mauborgne [15] similarly argued that the firm is dependent on individuals' voluntary will to cooperate and share their expertise.

However, Greater sharing is not always reached. Even in work groups, individuals do not always volunteer information that would allow the group to work efficiently and effectively [13]. Concerns of psychological safety and trust lead people to hide or hoard information and knowledge. In the knowledge economy, knowledge is seen to be the source of power [8]. Information can be seen as an asset that is to be owned and controlled by individuals in order to elevate their own power and status relationships in organization [16]. An atmosphere lacking in trust leads to the withholding of information and can be harmful to knowledge sharing. Davenport [7] concluded “As people's jobs and roles become defined by the unique information they hold, they may be less likely to share that information- viewing it as a source of power and indispensability- rather than more so.”

Organizational cultures have effect on individuals' beliefs of trust and psychological safety. Individuals that rated their organizations high on solidarity- relationships based on common tasks, mutual interests, and shared goals, and sociability- relationships based on friendliness, rated high on trust. A culture characterized by solidarity and sociability perhaps gives them a sense of confidence that their behavior would be fairly reciprocated with appropriate benefits or rewards by the organization.

On the other hand, psychological safety was significantly affected by employee-oriented (concern for people) versus job-oriented (concern for getting the job done) and need for achievement (importance placed in the organization on advancement and prestige). Those that characterized their organizations with higher need for achievement and more employee-oriented felt psychological safer than those did not.

Propensity to share information and knowledge are positively associated with trust. Support was found for all three scenarios. As predicted, Employees who perceived higher trust in their organization were more likely to share information and knowledge with others.

Partial support was found for the psychological safety hypothesis. We had hypothesized that psychological safety would be positively associated with the propensity to share information and knowledge, but the result suggests only significant association in information sharing scenario.

This study tried to show how cultural and interpersonal factors-trust and psychological safety-

influence information and knowledge sharing propensity. With the more uncertainty, more change, and less job security in future organizations, organization have to endeavor to build trust climate and provide more psychological safety for individual at work.

The samples of this study were gathered from college on-the-job students and the sampling method was convenient rather than randomized, the generalizability may be questioned. It is important to note that we used a cross-sectional design. Thus the result show in Figure 3 can only be considered suggestive of possible causal relationships until more appropriate longitudinal studies with random samples are conducted. Although we found several of the relationships in our study to be statistically significant, several were not. The lack of significance might be due to the methodological defects.

## Reference

- [1] Argyris, N.S., “The impact of information technology on coordination: evidence from the B-2 ‘Stealth’ bomber.” *Organization Science*, 10, 2 (March/April, 1999), 162-180.
- [2] Barnes, B. (1988) *The Nature of Power* (Cambridge, Polity Press/Basil Blackwell).
- [3] Brief, A.P., and Motowidlo, S.J. Prosocial organizational behaviors. *Academy of Management Review*, 11, 4 (1986), 710-725.
- [4] Burstin, K.; Doughtie, E.B.; and Raphaeli, A., “Contrastive vignette technique: an indirect methodology designed to address reactive social attitude measurement,” *Journal of Applied Social Psychology*, 10, 2 (1980), 147-165.
- [5] Constant, D.; Kiesler, S.; and Sproull, L., “What's mine is ours, or is it? A study of attitudes about information sharing,” *Information Systems Research*, 5, 4 (1994), 400-421.
- [6] Culnan, M.J., and Armstrong, P.X., “Information privacy concerns, procedural fairness, and impersonal trust: an empirical investigation.” *Organization Science*, 10, 1 (January/February 1999), 104-115.
- [7] Davenport, T.H.; Eccles, R.E.; and Prusak, L., “Information politics,” *Sloan Management Review*, 34, 1 (1992), 53-65
- [8] Davenport, T.H., “Information Ecology,” Oxford: Oxford University Press, 1997.
- [9] David W De Long, “Diagnosing cultural barriers to knowledge management,” *The Academy of Management Executive*, Briarcliff Manor; Nov 2000; Vol. 14, Iss. 4; pg. 113, 15 pgs
- [10] Drucker, P. F., E. Dyson, C. Handy, P. Saffo, and P. Senge. 1997., “Looking ahead: Implications of the present,” *Harvard Business Review* (Sept/Oct): 18+.
- [11] Edmondson, Amy, “Psychological safety and learning behavior in work teams,” *Administrative Science Quarterly*, Ithaca; Jun 1999; Vol. 44, Iss. 2; pg. 350, 34 pgs
- [12] Goffee, R., and Jones, G., “What holds the modern company together?” *Harvard Business Review*. 74. 6 (1996). 133-148.
- [13] Hightower, R., and Sayeed, L., “Effects of communication mode and prediscussion information distribution characteristics on information exchange in groups,” *Information Systems Research*, 7, 4 (December 1996),

- 451-465.
- [14] Hofstede, G.; Neijen, B.; Ohayv, D.D.; and Sanders, G., "Measuring organizational cultures: a qualitative and quantitative study across twenty cases," *Administrative Science Quarterly*, 35, 2 (1990), 286-316.
  - [15] Kim, W.C., and Mauborgne, R., "Procedural justice, strategic decision making, and the knowledge economy," *Strategic Management Journal*, 19, 4 (1998), 323-338
  - [16] Mohr, J.J., and Sohi, R., "Communication flows in distributed channels: impact on assessments of communication quality and satisfaction," *Journal of Retailing*, 71, 4 (1995), 393-416.
  - [17] Mullin, PL 1996. "Knowledge management: A cultural evolution," *Journal of Business Strategy* (Sept/Oct): 56-61.
  - [18] Orlikowski, W.J., "Learning from notes: Organizational issues in groupware implementation," *Proceedings of the Conference on Computer Supported Cooperative Work*. New York: Association of Computing Machinery, 1992, pp. 362-369.
  - [19] Robert, D.C., Selim, S.I., and Jason, J.B., "A Multi-Dimensional Study of Trust in Organizations," *Journal of Managerial Issues*, Vol. X, Number 3, 1998, Fall 1998, 303-317
  - [20] Scholz, C. "The symbolic value of computerized information systems," In P. Gagliardi (ed.), *Symbols and Artifacts*. New York: Aldine de Gruyter, 1990, pp. 233-254.
  - [21] Sirkka L Jarvenpaa, "Exploring perceptions of organizational ownership of information and expertise," *Journal of Management Information Systems*, Summer 2001; Vol. 18, Iss. 1; pg. 151-183
  - [22] Stewart, T. A. 1997. "Why dumb things happen to smart companies: Symptoms of bad brainpower management," *Fortune* (June): 159-160.

# An Overview of Financial E-Commerce

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## Abstract

This study examines the benefits and problems arising from the electronic brokerage services and the electronic investment banking processes. Some important benefits of the electronic financial services include greater transparency, more unprecedented opportunities for innovation and competition increase in trading volume, and creative methods for risk reduction. Problems about online broker-dealers and electronic investment banking include lack of direct contact between investor and broker, and glitches in the technology that inconvenient the end users. In the equity market, the channel of distribution through online IPO is limited when compared to traditional public offering through underwriters.

One important problem with financial e-commerce is the security and privacy problem. The security issue of online trading business can be divided into two parts: hardware security and software security. Hardware security problems involve network corruption, system crash, communication problem between networking servers and execution servers. Software security problems involve hacking, insider fraud, and account information theft. Brokerage firms use multiple security mechanisms to deal with these problems. These security mechanisms include: (1) Account and password control. This is the basic security control. (2) Encryption of transaction data. Transmission of data online always involves security flows.

Government as well as online financial service providers needs to take responsibilities to educate and communicate with investors to help them understand the benefits and risks of electronic financial services. To create a healthy investment environment is also vital to the future development of an electronic equity market.

## 1. Introduction

Today, the Information Technologies have achieved wide spread acceptance as one of the means to allow an organization to improve efficiency and productivity, to

become more responsive to the changing market in which it operates by developing, producing, and selling new products and to provide better levels of service to its customers. The Internet and the electronic data processing have also made a considerable impact on the financial industry. These technological advances change the ways of doing business in the financial markets.

One of the most successful examples of electronic commerce in financial markets is the electronic brokerage service. In particular, the electronic on-line ordering system (e-trading) has increased the efficiency of information flows and the trading process. The official trading hours can no longer limit security traders; investors are able to trade in global equity markets across different time zones, which may enhance their liquidity position. The electronic investment banking process is another example of electronic commerce that affects the traditional underwriting business. When raising capital, issuing companies can avoid underwriting spread and directly access capital markets through on-line initial public offering.

The purpose of this study is to examine major issues that are related to the e-commerce in the financial markets. We will examine the benefits and problems arising from the electronic brokerage services and the electronic investment banking processes. This study will also address the security and privacy problem, which is an important limitation to the development of financial e-commerce.

## 2. Advantages and Disadvantages of Electronic-trading and Investment Banking

### 2.1. Advantages of the Electronic-Trading System

The electronic trading of securities on the web has dramatically increased. Over the past few years, on-line securities sales went from zero, to more than a third of all retail trades [1]. Mutual funds have also taken a prominent position on the Internet, moreover, web-based

advisory services are provided. The benefits of the electronic trading include:

*(a) Operational Capability and Efficiency are Increase*

In the 1960s, many broker-dealers choked on the vast streams of paper flooding their back offices. It violates the SEC anti-fraud provisions to accept or execute any order for the purchase or sale of a security, if the broker-dealer do not have the personnel or facilities to enable it to promptly execute and consummate all of its securities transactions<sup>1</sup>. This is no longer a problem with the new information technologies; however, the network and server's capability are of concern. The good news is servers and networking bandwidth are less costly and their prices could only go lower in the future.

Most broker-dealers use powerful microcomputers to support their market making and brokerage functions. These workstations allow individuals to simultaneously perform multiple trade support functions, such as order management, monitoring net long or short positions in specific securities, calculating profit or loss real-time, analyzing risk and receiving market data [2]. Other trade support functions include trade reporting, records of completed transactions, links to back-office systems and order routing to various execution points. In addition, some broker-dealers provide order transmission capabilities to their registered representatives, correspondent broker-dealers or customers to permit them to electronically transmit all relevant information concerning an order to the broker-dealer's trading desk.

*(b) Cost Efficiency*

Since the whole trading process mainly concerns with the information flow, the difference between traditional trading and electronic-trading is the change of intermediary. Electronic trading technology is cost efficient, the start-up costs as well as the operating costs are lower than the traditional trading system. Electronic trading technology changes the dynamics of the marketplace. It removes at least three physical constraints imposed on markets. First, the physical space constraint no longer exists. The floor members on the tradition stock exchange have time and place advantages over those off the exchange floor in the past. With the electronic trading system, investors trade in the cyberspace, time and place advantages of the floor member become less significant.

With Internet and the e-trade system, investors can (1) place their orders anytime anywhere with Internet connection, (2) get instant information of their investing objects and also get the full information service from the online brokerages, and (3) lower their trading cost [1]. The lowering trading cost is evident from Graph 1.<sup>2</sup> The commission on a per share basis decreased from 8.1 cents in 1991 to 6.2 cents in 1998 for exchange-listed stocks, and from 7.4 cents in 1995 to 6.3 cents in 1998 for over the counter stocks. The electronic trading process plays

an important role in the reduction of trading commissions. For investment companies and brokerage firms, they could (1) increase their appearances though Internet, (2) attract the Internet age customers to broaden their customer base, and (3) decrease the management and human resource cost would be decreased [1]. In addition, Electronic trading reduces the transaction cost, especially in high volatility stocks. This is evident from Graph 2.<sup>3</sup>

*(c) Better Information Dissemination*

In 1996, an estimated 30 million households owned a personal computer (or about 25% of all households in the country)[3]. A 1995 survey showed that ownership of personal computers among mutual fund shareholders exceeded the national average<sup>4</sup>. The growing use of personal computers and the Internet by the public has not been lost on the financial services community. A recent list of investment management firm web sites includes over 200 entries [4].

Through Internet, investors can easily obtain information from the market listed companies, on-line brokerage firms, on-line financial advising service companies and etc. Any information disseminated through Internet is instant. Investors may subscribe to a variety of services offering access to real-time market data, company profiles and earnings reports, mutual fund data, and news services over the Internet. In addition, most of the leading commercial on-line services receive data feeds from information vendors and provide such information to their clients.

The exchange-listed companies have aggressively used new technologies to communicate with their shareholders, as well as to deliver prospectuses and other required information to shareholders. Investment companies use new technologies to provide their shareholders with the opportunity to communicate with them electronically. The on-line brokerage firms provide financial advices, trading reports, market status and some other information services to their customers easily through electronic medias. With enhanced information dissemination technology, markets become more efficient.

*(d) Better Customer appeal and focused marketing*

With information technologies, financial institutions can analyze their clients' trading behavior, understand and better satisfied their needs. The electronic trading system will improve customer appeal. Market participants can be geographically dispersed since they don't have to be located on the premises. Electronic trading technology allows foreign investors to access the U.S. equity markets.

Many companies believe that Internet technology offers a valuable forum for communicating with current and potential shareholders [5]. According to a National Investor Relations Institute ("NIRI") survey, over 95% of companies with over \$1.5 billion in market capitalization,

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<sup>1</sup> L. Unger, "Technology and Regulation The Road Ahead" <http://www.sec.gov/news/speech/spch343.htm>

<sup>2</sup> Graph source: Greenwich Association

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<sup>3</sup> Graph source: Plexus Group, 1999

<sup>4</sup> Gavis, "Investment Company Institute, Fundamentals, Mutual Fund Research in Brief, 1995

and over 75% of companies with under \$1.5 billion in market capitalization, either already have or soon plan to establish a web site.

*(e) Market Without Boundary*

The electronic trading made possible a more efficient global equity market. Investors can hedge their investments in different stock markets worldwide. For instance, small investors can buy British Telecom's ADR in NYSE and hedge this investment by selling British Telecom in LSE. Cross-border equity flows have increased dramatically. Gross cross-border equity transactions, including all foreign purchases and sales of corporate securities in the United States, increased from under \$93 billion in 1980 to over \$1.5 trillion in 1994<sup>5</sup>.

## **2.2 Disadvantages of the Electronic-Trading System**

Although electronic trading system provides many benefits to the capital markets, relative to the traditional trading system, it is not without shortcomings. A major disadvantage of the electronic trading is the service quality is not as good as traditional trading. The e-trade system lacks interpersonal communications. Security advising is one of the responsibilities of a broker-dealer. For the unskilled investors, they may need assistance from brokerage firms' professional advices; the e-trade system is not able to provide face-to-face consultation. In addition, because on-line brokerage firms use e-trade system to lower their costs, they may not hire enough employees to deal with emergent difficulties.

Today, complaints against online broker-dealers include (1) brokers fail to process orders or delay their execution and investors experience difficulty in accessing their accounts or contacting their brokers; (2) brokers making errors in processing orders, in account records, or investors experiencing execution problems. Most of these complaints against online brokers involved glitches in the technology.<sup>6</sup>

## **2.3. Advantages of Electronic-Investment Banking**

Raising capital on-line has clear benefits, for example, it is quick and broad in dissemination of information. The Internet provides companies direct access to a huge pool of investors and prospective investors. The Internet enables a company to distribute its offering materials to the broadest possible audience and to solicit interest in its securities without regard to location. This has proved a boon for new businesses without an established investor base as well as for established corporations seeking to leverage their name recognition on a global basis.

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<sup>5</sup> U.S Treasury Department.

<sup>6</sup> Laura Unger, "Investing in the Internet Age: What You Should Know and What Your Computer May Not Tell You", <http://www.sec.gov/news/speech/spch342.htm>

The use of electronic media to disseminate offering materials has some obvious economic advantages. It can reduce costs associated with the capital formation process, printing and distribution costs as well as advertising and promotion expenses. Electronic offering materials can also be supplemented and updated more efficiently and economically. These savings have significantly reduced the cost of capital, particularly for smaller businesses where such costs take a significant part out of the total offering proceeds.

One of the common complaints about underwritten offerings is the imprecision of the pricing process. In order to ensure the complete sale of securities, the lead underwriter and the investment bankers may under-price the offering securities to attract investors. One way to eliminate the under-pricing in the initial public offering process is to use the online "auction" pricing approach. In theory, this auction process should result in the maximum amount of offering proceeds for the company, while ensuring a more equitable distribution of offering shares.

## **2.4. Disadvantages of Electronic Investment Banking**

Most concerns involved in online initial public offering (IPO) are around three subjects: channel of distribution, liquidity issue, and education of participant investors. Underwriters normally acted as a "gatekeeper" in the security offering process. They conduct due diligence about the issuer and the offering, participate in preparing the registration statement, make pricing decisions, and provide research and aftermarket support. Without an underwriter, investors must rely on the issuer to carry out these responsibilities. Issuers would also retain sole liability for material omissions and misrepresentations. Compare to traditional public offering, online public offering can't provide as the same quality financial services and disclosures as traditional ones.

The channel of distribution through online IPO is limited. The purpose of public offering is to distribute securities to the public investors. However, it is difficult for online public offering to do the "massive" distribution. Currently, the online underwriting accounts for two percent of all initial public offering capital. According to the survey of Credit Suisse First Boston Technology Group, until year 1999, there were only five online underwriting players in the online underwriting business.

For the online public offering market, because of the small percentage of whole underwriting market and distribution problems, the issuing shares in the market are scares. Moreover, because participant investors are relative fewer than the traditional public offering, liquidity is reasonable lower than traditional ones. Until Internet-based services develop established customer bases and access to a liquid market for secondary trading, they pose little threat to traditional investment banks.

### 3. Security and Privacy Issues

There are limits and challenges of new web-based information technology to equity market. Among them, the most important one is the security issue. Investors would only invest their money in a secured environment, and this privacy concern applies to the entire e-commerce. In this section, we will discuss the current security mechanisms for the online investment, the tools and applications that online brokerage firms use to protect their customers, and we will also discuss the privacy issue.

#### 3.1 Privacy and Security Issues

Approximately thirty broker-dealers currently offer online trading. Most of these are discount brokers, and they offer a substantial discount on commissions for their clients [6].<sup>7</sup> The number of firms offering on-line trading will continue to grow, as compliance and security problems being resolved. Most broker-dealers require their customers to use an Internet browser that supports encryption, assuming this level of encryption to be sufficient to protect their information flows. Therefore, how to ensure the security in the online trading environment is important for the online brokerage firms to attract the perspective customers.

The security issue online trading business can be divided into two parts: hardware security and software security. First, hardware security problems involve network corruption, system crash, communication problem between networking servers and execution servers [1]. Among them, network corruption and system crash are mainly relates with online brokerage firms' systems capacity. The communication problem between networking servers and execution servers is mainly related to how brokerage firms manage their information systems. Today, with the advanced network technology, cost of bandwidth and processing devices is low and they are no longer serious concerns.

Software security problems involve hacking, insider fraud, and account information theft [1]. Brokerage firms use multiple security mechanisms to deal with these problems. These security mechanisms include: (1) Account and password control. This is the basic security control. (2) Encryption of transaction data. Transmission of data online always involves security flows. In order to ensure the integrity and confidentiality of data, the following mechanisms are used:

(a) *Secured Socket Layer (SSL) & Transport Layer Security (TLS)*

SSL/TLS providers a range of security services for client-server session. This security mechanism can provide server authentication, confidentiality, integrity, and client authentication [6]. By implementing SSL/TSL, brokerage firms can ensure that third party will not manipulate orders made from their customers. In

addition, with client authentication feature implemented, brokerage firms can ensure the source of orders.

(b) *Data Encryption Standard (DES)*

DES was adopted by United States federal standard in 1977.<sup>8</sup> DES is a block cipher operates on 64-bit blocks of data and employs a 56-bit key. DES can also ensure the integrity of transmitted data [6]. The demise of DES as a cryptosystem suitable for commercial use resulted primarily from its comparatively small key space.

(c) *Firewall*

Firewall is the most powerful and commonly used mechanism for online security. It is a system that enforces access control policy between two networks. The firewall determines which inside services can be accessed from the outside and vice versa. The firewall can be thought as a pair of mechanisms: one to block traffic and one to permit traffic. The firewall system performs like a guard watching the network traffic.<sup>9</sup> Firewall can provide can effectively prevent network intrusions and hacking.

### 4. Conclusion

While the full effect of recent technological developments remains to be seen, these developments have significantly changed the ways in which many investors obtain information about their investments and conduct financial transactions. Overall, recent advances in technology have brought greater transparency, provided unprecedented opportunities for innovation and competition, facilitated tremendous increases in trading volume, and made possible the development of methods to reduce risk. There are many benefits the information technology brings to the equity market, both for trading and investment banking.

The effective use of technology is the key to maintain active and competitive equity market. Technology has infused our equity market and its participants with a new and greater drive to compete. Equity market is being challenged every day to reexamine their business models, to reevaluate their services, and, in some cases, to reinvent itself. The pace of change and the strength of the securities markets generally have enabled investors to more directly participate in the securities markets.

Online brokerage has significantly changed the dynamics of the marketplace, causing one of the biggest shifts in individual investors' relationships with their brokers. It provides investors with tools to analyze information, and to act quickly on this information. Investors who use the online investing tools need to be more educated. Government as well as online financial service providers needs to take responsibilities to educate and communicate with investors to help them understand

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<sup>7</sup> Merrill's Mixed Up Internet Trading Strategy, Bank Technology News, June 1997.

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<sup>8</sup> U.S Department of Commerce, Data Encryption Standard, Federal Information Processing Standards Publications FIPS PUB46

<sup>9</sup> Source: 3com Co., "Network Security", 2000.

the benefits and risks of investing online. To create a healthy investment environment is also vital to the future development of an electronic equity market.

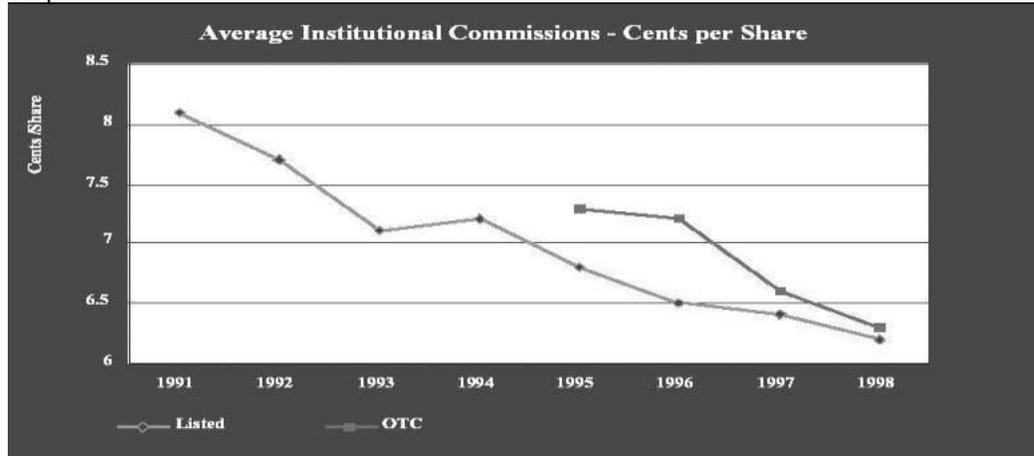
### Reference

- [1] Yungi Chen, Junghao Huang, “ Internet Security Trading”, 1999.  
[2] Kathryn George, “To Build or to Buy a New Trading System”, *Traders Magazine*, Feb. 1997.

- [3] Robert A. Robertson, *Personal Investing in Cyberspace and the Federal Securities Laws*, 1996.  
[4] Cliff Alexander, “Compliance in Cyberspace”, *The Investment Lawyer*, June 1997.  
[5] Rivel Research Group, “Utilizing Technology in the Practice of Investor Relations” Aug 1999.  
[6] Ford, Warwick, and Michael S. Baum, “Secure Electronic Commerce”, second edition, 2000.

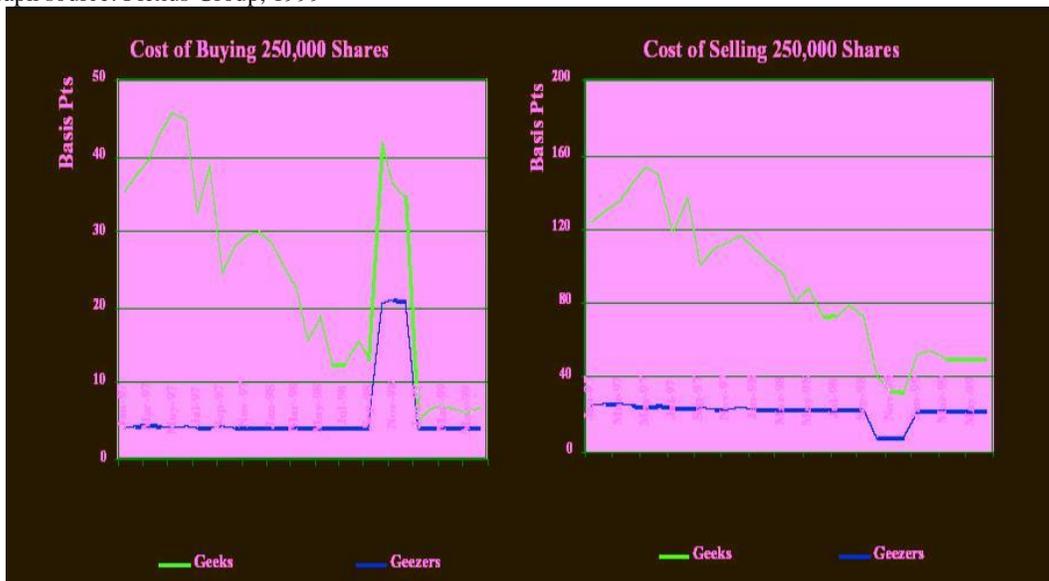
Graph 1 Average Trading Commissions

Graph source: Greenwich Association



Graph 2 Transaction Costs of High Volatility Stock

Graph source: Plexus Group, 1999



Geeks: Amazon, AOL, Lyco's, Netscape and Yahoo.  
 Geezers: General Electric, Exxon, IBM, Coca-Cola, & General Motors

# The Impact of ECN on the Trading Structure of Taiwan's Securities Market

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## Abstract

Along with the booming of internet, many enterprises have modified their business models accordingly, which then has influenced the trend and direction of many industries. In the securities market, investors could utilize internet to obtain order information more easily and completely. Especially, with the easy access of foreign securities information through internet, investments transactions are becoming globalized too. Traditional trading support no longer satisfies investors' requirements. That has contributed to the global rise of electronic communications networks (ECNs). These new trading platforms make the competition among exchanges more severe. With the gradual opening of Taiwan's financial market, the approaching of these new players becomes inevitable. We study the impact of ECN on the trading structure of Taiwan's securities market, based on the trading contents, trading methods, and trading support requirements. We first analyze the impact of ECN on the trading structure of United States securities market. Current trading structure of Taiwan's securities market is then analyzed for stocks, bonds, and futures separately. We also develop an experimental ECN with the negotiation mechanism. The system is then tested by several trading experts. Their answers to our survey are summarized as our conclusion.

## 1. Introduction

The trading functions of traditional securities exchanges are order matching, clearing, and settlement. Electronic Communications Networks (ECNs) accomplish order matching electronically, and provide an open platform for individual and institutional investors. Although most brokerages in Taiwan are already engaged in providing electronic order entry through internet, the current electronic trading services provided by Taiwan's securities exchanges are insufficient, which limited the whole effects of internet. For example, although investors could enter orders through internet anytime, matching for after-hours orders will be delayed to the official trading time next day. Furthermore, real-time price information is incomplete, and the trading cost for investors is still high.

Before joining WTO, Taiwan government had modified law so that Taiwan's stocks, bonds, and futures exchanges will no longer enjoy current monopoly by opening securities

market to foreign competitors [5]. Since the setup of ECN is relatively easy and inexpensive, the first competition they would encounter would be from ECN. ECNs in the United States have created new forms of derivative portfolios and attracted individual investors. We would like to have a systematic study on the impact of ECN on the trading structure of Taiwan's securities market.

Because most institutional and individual investors in Taiwan do not have any experience of ECN, we implement an experimental ECN system to help them understand ECN's functions and characteristics. Besides normal trading operations like order inquiry, price inquiry, and matching, the system also provides risk management and negotiation mechanisms. We then interview several trading experts after they test the system. Their answers to our survey are then systematically analyzed to investigate the impact of ECN on the trading structure of Taiwan's securities market based on trading contents, trading methods, and trading support requirements. In trading contents, we will emphasize on the demographic change of trading investors and the migration of trading goods. In trading methods, will focus on the percentages of order entry and matching choices. In trading support requirements, we will focus on the demand of the trading support tools and of trading information. This analysis architecture is applied both to Taiwan's and U.S. securities markets.

## 2. Related Work

In this section, we introduce ECN. Its origin, functionalities, characteristics, and current status are discussed first. The impact of ECN on the trading structure of U.S. securities market is then analyzed.

ECN is defined as any electronic system that widely disseminates to third parties orders entered into it by an exchange market maker or over-the-counter market maker, and permits such orders to be executed in whole or in part [16]. It originally appeared as Alternative Trading System (ATS) by providing a proprietary communication channel and information display for private trading of institutional investors and broker-dealers. It added order matching functions like traditional exchanges, and provided real-time price information through internet. Although Meridien Research predicted ECN will be a short lived phenomenon under electronic automation of traditional exchanges[11],

with the low cost in establishing and maintaining ECN, trade share volumes through ECN in Nasdaq has already reached 33.1% in May, 2002 [12], rising from 25.8% in September, 2000 [13].

The functionalities of ECN could be classified as follows: (1) Real-time matching: Order matching is the most important function of ECN. Once orders are entered into ECN, the matching mechanism will immediately process them. (2) Anonymous trading: Current ECN matching does not reveal the identities of order holders. This improves the willingness of investors to participate in the market, and reduces the impact of individual orders on the market. (3) Real-time price information: In U.S. traditional exchanges, the trading process is unfair to most investors since they do not have the channel to obtain complete real-time price information. ECN attracts investors by providing real-time complete price information like "which identity number issued what orders at what time". (4) Order transfer: ECN match orders inside its own system first. For orders unable to match inside, it could search other connected ECNs for orders matched with the best price, and then transfer the orders to that ECN.

The characteristics of ECN are as follows: (1) Fast trading: The order entering and matching in ECN could be completed without human participation, which improves the trading speed dramatically. According to McAndrews and Stefanadis [6], the average processing time for each order in an ECN in the United States was 2 to 3 seconds in 1999, compared to 22 seconds in the traditional exchanges. (2) Low cost: According to McAndrews and Stefanadis [10], in 2000, the personnel costs incurred from operators and dealers in NYSE and Nasdaq were about 55% and 25% respectively. Without much of the human participation, the operation cost of ECN is greatly reduced. Many ECNs have thus lowered the service charges to participating investors. (3) Long tradable time: Not only the order entry and matching are uninterrupted by weekends and holidays, but also are services improved by after-hours trading. Investors could make prompt trading decisions based on up-to-minute events. (4) Huge trade volume: The easy connection to the order entry system of brokers and other ECNs increases matching opportunities for orders. The low cost of ECNs also reduces the service charges imposed on the investors. The above two factors contribute to the increased ECN trade volume in Nasdaq. (5) Open structure: Traditional exchanges only allow their member brokers to connect to their system. The procedures of joining traditional exchanges and the establishment of their system take a long time. Non-member brokers need to enter orders to member brokers of a traditional exchange to trade their orders in that exchange. ECNs provide a standard application program interface for brokers and investors to easily establish connection.

## 2.1 Current Status of ECN

Current ECNs have two trading modes: open and closed. After receiving an order, ECNs will try to match it with other orders inside immediately. If the matching does not succeed, in ECNs with open trading mode, they will try other connected exchanges or ECNs, while in ECNs with closed trading mode, they will not.

The most developed and sophisticated ECNs are in the United States for stocks listed in Nasdaq. There are three cross-border ECNs in Europe. Singaporean and Australian stock exchanges have formed an alliance to trade their listed stocks. Many Japan's and Taiwan's internet brokerages have worked together with U.S. ECNs for international market information. These could be perceived as a trend in the acceptance of the idea of ECN. The percentage of trade dollar volume through ECN in Nasdaq in May 2002 is 36.2% [12], increased from 32.2% in September 2000 [13]. In 2001, besides stocks, four ECN's in the United States provide bonds trading, and two provide capabilities to trade European stocks. Jupiter predicted that the online trade dollar volume will reach 5.4 trillion U.S. dollars in 2005 [14]. ECN will enjoy the most significant increase in this trend.

## 2.2 The Impact of ECN on the Trading Structure of U.S. Securities Market

Before ECN, most trade volumes in traditional exchanges mostly came from human negotiations by market makers. After the establishment of ECN, the following changes in trading structure have been observed:

### 1. Trading contents:

- A. Growth of the percentage of individual investors: In the United States, the order information was unfair to individual investors in traditional exchanges. The service charges for them based on number of transactions were high for individual investors. Most individual investors needed to delegate professional dealers to handle their investments. In ECN, the information is fairly shared among individual and institutional dealers. ECN's service charges are relatively low compared to those of traditional exchanges. These contribute to the increased percentage of individual investors.
- B. Growth of new forms of derivatives: Derivatives were inconveniently traded through telephones before ECN, which made their trade volumes low. ECNs provide an easy to access environment both for information inquiry and for transaction completion for derivatives. It makes new forms of derivatives, like exchange of baskets of stocks, possible.

## 2. Trading methods:

Growth of the percentage of electronic trading: Traditional matching was through negotiation by market makers, which is inefficient and error prone. ECNs provide an easy to access electronic platform for order entering and matching. The percentage of trade share volumes through ECN in Nasdaq has increased from 25.8% in September 2000 [13] to 33.1% in May 2002 [12]. This statistics does not count orders matched inside each ECN or between ECNs. Therefore, the actual percentage of stock volume traded through ECN in Nasdaq is even higher.

## 3. Trading support requirements:

- A. Increased demand for professional trading tools: Many new trading tools emerge after the appearance of ECN. For example, global market maker HullTrading [8] linked all exchanges and ECNs to provide a complete market linkage trading system. It helped the investors to search the best price in the market, and to enter orders in the appropriate ECNs or exchanges to obtain the best price margin.
- B. The emergence of the requirement of consistent price information: ECNs caused the fragmentation of the securities market. The investors could enter their orders in both traditional exchanges and ECNs freely, which caused different prices for the same stock. The problem is especially severe when the market is hot.

## 3. Current Trading Structure of Taiwan's Securities Market

We will survey the current trading structure of Taiwan's stocks, bonds, and futures market separately in terms of trading contents and trading methods. Due to slow financial reform, the trading support requirement in Taiwan's securities market is mainly on the opening and linking of foreign and domestic markets. We will not survey this aspect in the following.

### 3.1 The Trading Structure of Taiwan's Stocks Market

#### 1. Trading contents:

The percentage of individual investors in Taiwan is relatively high. For example, the percentage of individual investors was 87% in February 2001 [17]. According to Taiwan Stock Exchange Corporation (TSEC), the number of individual investors involving internet issuing is about 317,000 in August 1999 [3], and the number has increased to 2.16 million in March 2002 [2], about 10% of Taiwan's population. It is easy to see that the acceptance of internet among Taiwanese investors is very high. In terms of trading

goods, due to the relative closeness of financial laws, the number of derivatives regarding stocks and other securities is low.

## 2. Trading methods:

Current trading methods could be classified as follows:

- i. On spot orders: investors could enter delegation orders in person in the brokers' counters.
- ii. Telephone orders: Investors could call the brokers to relay their order information, which will be filled in to the delegation orders by the operators.
- iii. Internet orders: Investors could fill in order information in their broker's web sites.
- iv. Programmed telephone orders: Investors could call a special telephone number to issue orders by answering programmed instructions.
- v. Mobile orders: This is similar to internet orders, except the media is now through WAP or GPRS of cellular phones.

Note that after the orders are entered, order matching is then performed in TSEC electronically in the official working hours. Chang [1] argued that TSEC is already like a big ECN in terms of order matching. However, with the definition in Section 2, we do not treat TSEC as an ECN. Currently, most order entries are through telephone. According to TSEC, the percentage of electronic order entering was 8.66% in the first quarter of 2002 [2], rising from 7.29% in October 2000 [9].

## 3.2 The Trading Structure of Taiwan's Bonds Market

#### 1. Trading contents:

Current trading unit for bonds in Taiwan is NT 50 million dollars. Since the minimal trading value is huge, most investors are institutional dealers. The trading goods include government bonds, corporation bonds, monetary bonds, and cross-country monetary bonds. Trading modes are classified into outright purchases (OP) and repurchase and reverse repurchase (Repo, Reverse Repo). In OP, the ownership of traded bonds is transmitted to the purchaser on the date of the transaction. In Repo, the seller agrees to purchase back the bonds in a fixed date with an agreed interest rate. In Reverse Repo, the buyer agrees to sell the bonds back to the seller in a fixed date with an agreed interest rate.

#### 2. Trading methods:

Most bonds in Taiwan are traded over the counter in brokers' offices through individual negotiations. This makes the whole trading process and pricing information neither transparent nor real-time. The trading is either through telephone conversation or through the bond trading system

operated by GreTai Securities Market (GTSM, formerly Over-the-Counter Securities Exchange). However, the bond trading system in GTSM is mainly for batch trading among professional bond dealers, and it is not open to investment companies and individual investors. Although this system could generate matching information during trading sessions, it does not proactively notify the dealers their trading results. With slow response and insufficient functionalities, the system does not receive good market reaction.

### 3.3 The Trading Structure of Taiwan's Futures Market

#### 1. Trading contents:

Taiwan only opens index-based futures markets. Taiwan's domestic futures market started trading in July 1998, with the product Taiwan weighted stock index futures. Taiwan electronic and banking & insurance sector stock indexes were listed in July 1999. Taiwan stock index options was then listed in December 2001. The percentage of individual investors in Taiwan's futures in terms of trade volumes in lots is about 95.92% for the first half year of 2002 [15]. Initial margins in Taiwan's futures market are much higher than those in the United States. In addition, since there is a 7% fluctuation bound in Taiwan's stock market, the daily gain or loss in Taiwan's futures is also limited.

#### 2. Trading methods:

Taiwan's futures are already traded electronically. However, information of foreign futures, like commodities or SIMEX MSCI Taiwan Stock Index Futures, is hard to obtain, and trading channels for them are inconvenient.

## 4. The Design and Implementation of an Experimental ECN

### 4.1 System Requirement

Besides the aforementioned ECN functionalities of real-time price information, immediate matching, order transfer, and standard API, we believe a negotiation mechanism with an ICQ-like interface with log capability is very important. The log could provide negotiation history, evidence when there is an argument, and confirmation after the negotiation is complete.

### 4.2 System Architecture

Fig. 1 demonstrates the system architecture for our proposed ECN. The investors in the left of the dash line represent the client side of the system to enter orders through internet. The main modules are as follows:

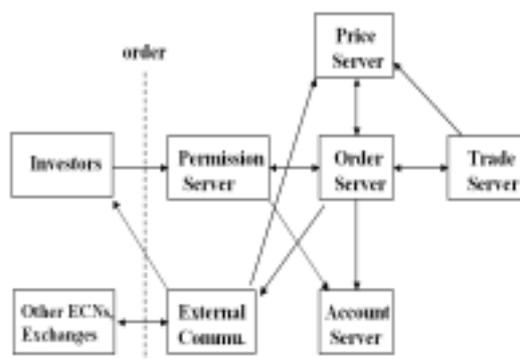


Fig. 1: System Architecture of Our ECN

1. Permission server: It is responsible for registration, security and authentication control. Negotiation and usage logs are recorded here.
2. Order server: It is responsible for coordinating all order related operations. It will dispatch orders to corresponding modules based on their status. Other modules will report their processing results to it too. It will also proactively transmit order information through External Communication to interested investors and brokers in other ECNs. Chen [4] provided details about its operation.
3. Trade server: It is responsible for order matching. After it receives the order information from order server, it will try to match the order immediately. The result will then be sent back to order server.
4. Price server: It stores the price information from trade server, order information from order server, and the external price information from other ECNs. External orders will be sent to order server for matching.
5. Account server: It is responsible for storing account related information, like current balance and detailed securities holdings, so that the user could inquire their financial data to perform risk management.
6. External communication: It is to handle communication with end users and other ECNs or exchanges. External orders will be sent to price server to store related information before matching. Orders unable to be matched in the system will be sent to other ECNs or exchanges through this module. For system extensibility, the format for the communication is FIX 4.2 [7], the format for standard financial transactions.

### 4.3 System Application

Brokers could handle the received order information based on their own needs. To verify the usability of our system, we also implement a testing client system for brokers to query information and enter orders. For example, a user could query price information for a bond by simply typing in the bond's number.

In addition to normal functionalities of ECN, we also provide the following extra functions:

1. Control of dealer's handling amount: We provide this mechanism for the broker to control the maximal daily handling amount for their dealers. It will prevent the broker from huge loss caused by adventurous dealers.
2. Negotiation: The negotiation mechanism could allow the investors to negotiate with several dealers simultaneous to obtain the best price.

### 5. The Impact of ECN on the trading structure of Taiwan's Securities Market

In this section, we first explain the background of the inevitability of the approaching of ECN. Questions for several trading specialists are then presented. Their answers to these questions are then summarized according to the analysis structure in Section 2.

There are two main reasons why the approaching of ECN is inevitable:

1. The trend of cross-country trading: Currently when an Taiwanese investor plans to participate in foreign securities market, the usual channel is through purchasing mutual funds for foreign securities. If he wants to handle the investment in person, then he needs to enter orders in various foreign exchanges, which is very inconvenient. The capability of order transfer in ECN is an off-the-shelf solution to alleviate this issue. Most corporations also are willing to have their stocks or bonds traded cross-border to collect capital. Global cross-country exchanges have been booming recently. Euronext comprises stock exchanges of New York, Paris, Amsterdam, and Brussels. Nasdaq, London, and Frankfurt stock exchanges are already linked. Singapore and Australian stock exchanges have formed an alliance. The easy connection of ECNs also makes their entrance into other countries easy.
2. The openness of financial market after WTO: Before joining WTO, Taiwan government has removed the monopoly protection to domestic

exchanges. Foreign exchanges, ECNs, investment banks, etc., are entering into Taiwan's financial market with their professional knowledge and huge capital. For example, Taiwanese web sites, like Cnyes [6], have already linked with U.S. ECNs to provide real-time stock information. It is inevitable that Taiwan's financial market will link with global markets. Taiwanese brokers have started the process of merge and acquisition since 1999 to react to the emerging global competition.

We demonstrated our experimental ECN system to several trading specialists and asked them to test it. We then interviewed them with questions based on the analysis structure we mentioned in Section 2. Table 1 demonstrates the questions we proposed:

**Table 1: Questions to Taiwan's Trading Specialists**

Interview questions	Reasons for asking
What will be the advantage of ECN in Taiwan's current securities trading environment?	Since the securities trading environments are quite different in Taiwan and the United States when ECN is booming, some advantages of ECN in the United States may not hold in Taiwan.
What kind of ECNs will prosper in Taiwan?	Since order matching in Taiwan is already completed electronically, and order entry through internet has been booming in Taiwan, we believe the ECNs that will prosper in Taiwan will be different from those in the United States.
What will be the impact of ECN on the trading structure of Taiwan's securities market?	This is our research thesis.
What will be the influence of the negotiation mechanism on the trading methods?	We would like to investigate the effect of our ECN's ICQ-like negotiation mechanism on the trading methods of Taiwan's securities market.
What will be the impediments of ECN in Taiwan? Are there other missing functionalities?	We would like to understand the problems ECN will face in Taiwan.

Since the interview should be conducted to people with some background knowledge of ECN, it is difficult to find proper trading specialists for the interview. We only interviewed three specialists before December 2001. The following is the conclusion of our interview:

1. The impact of ECN on trading contents of Taiwan's securities market

a. Increased percentage of institutional investors: The percentage of individual investors in Taiwan is already very high. With the introduction of many new financial goods to Taiwan, ECNs will increase the flexibility of investment combinations of securities, and also increase the difficulty of investment management. Thus, individual investors will seek the help of trading specialists, which will increase the percentage of institutional investors in Taiwan's securities markets. On the other hand, in the United States, before ECN, since individual investors had difficulties in obtaining complete trading information, and the service charges were high, the percentage of individual investors was relatively low. ECN changed the above trading environment in the United States, and increased the percentage of individual investors.

b. Emergence of diversified securities goods: Taiwan's current tradable securities goods are limited. Besides easy combination of securities goods, ECN is suitable for cross-country trading. That will make the securities goods more diversified. Part of the investment capital will be moved to these new financial goods. Thus the percentage of stock investment in total investment will then be reduced. On the other hand, because the financial goods in the United States have been relatively complete before ECN, ECN has little impact on the percentage of securities goods, and it just increased the flow of current financial goods.

2. The impact of ECN on trading methods of Taiwan's securities market

a. Trading volume will be shifted to ECN: Although order matching in Taiwan is already completed electronically, it is performed in a black box. With the advantages of ECN, investors will be attracted to complete their orders in ECN, especially for after-hours market. On the other hand, in the United States, the reduce of percentage of trade volumes through non-ECNs in Nasdaq has been mainly due to the speed up of ECN compared to slow human negotiations by market makers.

3. The impact of ECN on trading support requirements of Taiwan's securities market

a. The growth of the demand of supporting investment tools: With the expected booming of new diversified investment goods, the demand for investment tools to analyze and to support trading of these diversified goods will also increase.

b. The emergence of the requirement of transparent

trading information: Current price information in Taiwan is not transparent in real-time for both institutional and individual investors. With the provision of complete ordering information in ECN, investors in the traditional exchanges will ask for the same support. On the other hand, in the United States, since individual investors did not have sufficient order information of orders from market makers, the demand of transparent trading information has been existent before ECN.

c. The emergence of the demand of negotiation mechanisms: Although order matching in Taiwan is completed electronically, the human negotiation process still exists in bond trading and after-hours market. They currently are completed mostly through telephone conversations. The demand for the negotiation mechanism will increase. On the other hand, the trading market in the United States before ECN had been mainly by human negotiation. The demand to add negotiation mechanisms in ECN was not so obvious in the beginning.

## 6. Conclusion

With the gradually opened Taiwanese financial market, most people have noticed the booming trend of internet brokerages. This trend has been extended to the traditional exchanges in other countries, and ECNs have already occupied noticeable market share already. However, the trend seems not noticed by most investors in Taiwan. We surveyed and accumulated related data about ECN in the United States. We designed and implemented an experimental ECN with the negotiation mechanism. The system was tested by Taiwan's trading specialists. Their interview answers were then summarized for the impact of ECN on the trading structure of Taiwan's securities market based on an analysis structure of trading contents, trading methods, and trading support requirements. The conclusion of our interview is as follows:

1. Securities goods will be more diversified.
2. The percentage of trade volumes from institutional investors will increase.
3. Part of the trade volumes will be shifted to ECN.
4. The demand for supporting investment tools will increase.
5. The requirement of transparent price information will arise.
6. The requirement of negotiation mechanisms will arise.

Future research topics include:

1. Investigation of required modification of regulating laws: Since the regulation about

securities trading is different for each country, it has become an obstacle in establishing a global trading market. Most financial reforms will need to adjust the current law in each country. A consistent and systematic investigation is needed to compare the differences in each country.

2. The enforcement of security: Since the trading dollar amounts are normally huge, it will become an obvious target for security intruders when order information is communicated electronically. Therefore, a proper design and implementation of network security mechanisms is very important.
3. The impact of ECN on the trading structure of securities market in other countries: It has been difficult for us to find related academic works about this research. We hope our research will be helpful for later investigation for other countries.

[15] Taiwan Futures Exchange  
<http://www.taifex.com.tw/taifex0305.asp>

[16] U.S. Securities and Exchange Commission, "Special Study: Electronic Communication Networks and After-Hours Trading", June 2000.

[17] Yan, Ching-Chang ASAF2000,  
<http://www.ctech.com.tw/newshtm/stock/900217041.htm>

## References

- [1] Chang, Wen-Yi "A Survey of the development and impact of ECN", *Taiwan Stock Exchange Corporation Research Report*, July 2000.
- [2] Chen, Chung,  
<http://yam.chinatimes.com/ctnews/news/200204/M9142705024152.html>
- [3] Chen, Li-An, Focus on Internet News and Data,  
[http://www.find.org.tw/news\\_disp.asp?news\\_id=626](http://www.find.org.tw/news_disp.asp?news_id=626)
- [4] Chen, Ming-Hung "A study of the impact of electronic communications network on Taiwanese financial trading mode", master thesis, Department of Information Management, Tamkang University, June 2001.
- [5] Chinese National Federation of Industries "WTO and the reaction strategies of industries", March 2002,  
<http://www.cnfi.org.tw/wto/wto-53-32.htm>
- [6] Cnyes, <http://www.cnyes.com>
- [7] FIX Protocol Specification Document,  
<http://www.fixprotocol.org/cgi-bin/Spec.cgi?menu=4>
- [8] Goldman Sachs, <http://www.hulltrading.com>
- [9] IThome news,  
[http://www.ithome.com.tw/Daily\\_news/20001218/index6.html](http://www.ithome.com.tw/Daily_news/20001218/index6.html)
- [10] McAndrews, James & Stefanadis, Chris "The Emergence of Electronic Communications Networks in the U.S. equity markets", *Current Issues*, October 2000, pp: 1-6.
- [11] Meridien Research, "ECNs — Who will the winners be?", July 1999.
- [12] Nasdaq Market Data,  
<http://www.marketdata.nasdaq.com/asp/MpECNMonth.asp>
- [13] Nasdaq Market Quality Statistics,  
<http://www.marketdata.nasdaq.com/mr6d.html>
- [14] Sterling, Robert & Van Dyke, James & Shore, Melissa & Shen, Tiffany "Financial Services Projections, The Personal Finance Interface", *Jupiter Research*, December 2000.

# Using Hidden Markov Model for Stock Day Trade Forecasting

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## Abstract

Around the world, the Hidden Markov Models (HMM) are the most popular methods in the machine learning and statistics for modeling sequences, especially in speech recognition domain. According to the number of patent applications for speech recognition technology from 1988 to 1998, the trend shows that this method has become very mature. In this thesis, we will make a new use of the HMM and apply it on day trading stock forecast.

However, the HMM is based on probability and statistics theory. In a statistics framework, the HMM is a composition of two stochastic processes, a Hidden Markov chain, which accounts for temporal variability, and an observable process, which accounts for spectral variability. The combination contains uncertainly status just likes the stock walk trace. Therefore, the HMM and the stock walk trace have the same idea by coincidence. In this thesis, we will try to learn the stock syntax; just like how the HMM model was used in speech recognition in different languages, and the take the next step ahead in price prediction.

Additionally, the stock market is the reflection of the economy. The stock trace is impacted by many factors such as policy, psychology, microeconomics, economics, and capital, etc. There, in this thesis, the TAIFEX Taiwan index futures (TX) and day trade are used to avoid all the uncertainty factors. After the all experiments, it is proven that the HMM is better than the benchmark method-Random Walk method and the Investment Trust & Consulting Association method- Modified Trading method. Moreover, the result is very conspicuous by the statistics testing of significance.

Key words : Day trade、Hidden Markov Model、Modified Trading method、Time series forecasting

## 1. Introduction

A typical problem faced by stock managers is to take invest that various stocks, or stocks classes, in an optimal way. To do this the stock manager must first develop a model for the evolution, or prediction, of the rates of return on investment in each of these stock classes. A common procedure is to stock of return are drive by rates of return on some observable factors. In this research we propose a model for the rates of return in terms of observable and non-observable factors; we present algorithms for the identification for this model, (using filtering and prediction techniques) and indicate how to apply this methodology to

the (strategic) stock prediction problem using a mean-variance type utility criterion.

Earlier work in filtering is presented in the classical work of Liptser and hirayayev. Previous work on parameter identification for linear, Gaussian models includes the paper by Anderson et al. [1]. However, this reference discusses only continuous state systems for which the dimension of the observations is the same as the dimension of the unobserved state. Parameter estimation for noisily observed discrete state Markov chains is fully treated in [2]. The present paper includes an extension of techniques from [2] to hybrid systems, that is, those with both continuous and discrete state spaces.

In recently, the Hidden Markov Model (HMM) is a popular technology in speech recognition domain. Especially in the telephone weather query, telephone timetable query, banking telephone services, telephone stock query, ... etc. Investigating into the G06 and G10 of the international patent classification (IPC) can find out that the speech recognition patents are growth from 1988 until 1998. Those patents are researched in Hidden Markov Models in the mostly. So it's implied the conclusion that the speech recognition technology is very ripe after 1998. This is illustrated in Fig. 1.1.

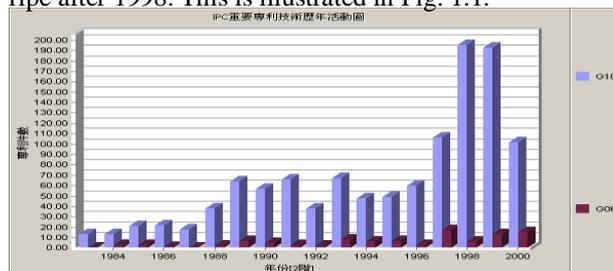


Fig1.1 IPC G10 and G06 analysis graph

As far as we know, the traditional speech recognition system shows the some major components. This is illustrated in Fig. 1.2. The digitized speech signal is first transformed into a set of useful measurements or features at a fixed rate. These measurements are then used to search for the most likely word candidate, making use of constraints imposed by the acoustic, lexical, and language models. Throughout this process, training data are used to determine the values of the model parameters. In this work, the input signal will be transfer into stock day trade wave signal.

In order to facilitate identification of objects from patterns, this work will assume that the set of patterns that can be produced by a component is finite. So this work will make some experiment for try to find out the pattern from

the day trade history records of the Taiwan Stock Exchange Capitalization Weighted Stock Index (TAIFEX future, TX) from 1998 to 2002. In additionally, according to the law source of the Securities and Futures Commission (SFC) day trade rule in May 1994. The law provides a lawful transaction rule to investor. This work will base on the law for approve the architecture feasibility.

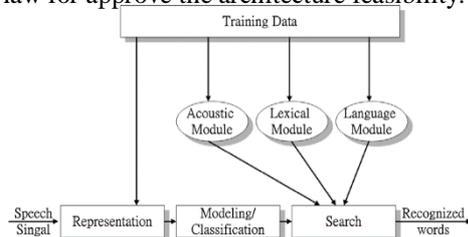


Fig1.2 The speech recognition system architecture

## 1.2 Research scope of this work

In this work, the research source data is the day trade history records of the TAIFEX futures (TX) from 1998 to 2002. As result of the records are day trades. So it will not be impacted form any factors. No matter policy, psychology, microeconomics, economics, capital, last night USA stock market etc. It's included the opening price, opening quotation, and closing price, closing quotation, volume, transaction price, high price and low price. It's total 866 days trade history records from 21, July, 1998 to 20, February, 2002. The training time is from 21, July, 1998 to 21, July, 2001. The simulation time is from 24, July 2001 to 20, February 2002. Additionally, this work will try to apply the HMM into the recognition model to be the forecasting strategy and compare two traditional invest strategy models. One is the Random walk[9] strategy model that is the benchmark model, and the other is the Investment Trust & Consulting Association Modified Trading model[18].

## 2. Background

### 2.1 Overview stock market theory

The trade credit is the generic term for a stock investor's purchase of supplies. In the traditionally, the vendors and suppliers are often willing to sell on credit and this source of working capital financing is very common for both startup and growing businesses. Suppliers know that most small business rely primarily upon a limited number of suppliers and that small businesses typically represent relatively small order risks; as long as the supplier keeps a tight rein on credit terms and receivables, most small businesses are a worthwhile gamble for future business. But the stock trade credit is be provided rule form SFC for those vender's want to buy stock but they have not enough money, or those supplier want to sell stock but they have not hold any stock. The rule has three systems include Purchase on margin, short on sell and day trade.( Purchase on margin ,Short on sell and Day trade)

The day trade is the generic term for a stock investor's to loan stocks or money from Stock Exchange Company and

sell or buy stocks in the same day. That is due to one of the lowest risk transaction process. In the other words, it's the lowest return transaction process. In fact the process have a very good operation in the same day. So it can evade the risk of the last night USA stock risk[19]. No matter what's happen, the investor just loss the 7% of capital even which the decision is wrong. So the day trade of the SFC provides a very stability trade system. But the day trade system has three previous conditions as below.[19]

- . The volume must over some quotation. That is because the investor can buy and sell into stock exchange market any times.

- . The price undulation must over some degree. That is because the investor can buy and sell into stock exchange market any times. So the investor can have at least returns.

- . The transaction cost must low or the returns of the investor will be reduce comparative.

Summing up the previous various reasons, the stock market cannot find out the stock to fit the each condition. But in fact, it is not adapting to the stock market day trade conditions. The conditions are more adapting to futures market. As well as, the Taiwan government trend to encourage investor to make uptrend. Just as the margin of finance margin trade is lower than the margin of stock margin trade. Such as the other rules limits to the buy and sell order. So the strategy of the operation is very important. The thesis will experiment in the TAIFEX futures (TX) .

### 2.2 TAIFEX futures (TX)

The TAIFEX futures (TX) contract is based on the SFC security and future laws. The TAIFEX futures (TX) is the generic term for each stock's volume of circulation, which enter the market, be weighted to calculate the index value. In other words, the big capital stock will impact over the small capital stock. It is mean that TAIFEX futures (TX) contract is based on the volume of circulation-weighted index to be the target. So the relation is very interdependence between the TAIFEX futures (TX) and the volume of circulation. Even the weighted index pulsating will bring the TAIFEX futures (TX) pulsating in the same time. So the investor does not need to study each stock changing. The investor just need to study the TAIFEX futures (TX).

### 2.3 Overview forecast time series theory

In the section, the thesis wills introduction two major basic time series stock forecast models, Linear forecast model and Non- Linear. forecast model. The section will introduction from basic model. So the section will introduce four linear forecast models and five non-linear forecast modules. The introduction will not only introduce the module theory and also introduce the application.

### 2.4 Overview Modified Trading method theory

In the current method of the Investment Trust and Consulting Association, the trader uses the population method of modified trading on day trade. About the method is follow as the experiment of the Investment Trust

and Consulting Association. So this work will to implementation the theory in an algorithm. The method can transfer to the below table. The method catches three statuses from three-time point. One is 9:05 and the other is 9:10, and other is 9:15. The three statuses can combine to a status series.

The Modified Trading method applies to all eight Full and Partial Gap scenarios above. The only difference is instead of waiting until the price breaks above the high; you enter the trade in the middle of the rebound. The other requirement for this method is that the stock should be trading on at least twice the average volume for the last five days. This method is only recommended for those individuals who are proficient with the eight strategies above, and have fast trade execution systems. Since heavy volume trading can experience quick reversals, mental stops are usually used instead of hard stops.

### 3. Hidden Markov Model

#### 3.1 Overview Hidden Markov Model

The Hidden Markov Model has been published form 1960s[5]. This model is based on the probability and statistics theory. The Hidden Markov Model is a finite set of states, each of which is associated with a (generally multidimensional) probability distribution. The model is the population method on the speech recognition domain. Transitions among the states are governed by a set of probabilities called transition probabilities. In a particular state an outcome or observation can be generated, according to the associated probability distribution. It is only the outcome, not the state visible to an external observer and therefore states are "hidden" to the outside; hence the name Hidden Markov Model. This work hope to applied the model in the stock day trade forecast.

As well the HMM has two major basic model which one is Continuous HMM(CHMM) and the other is Discrete HMM(DHMM) by the observation probability. As a result of the stock daily record is coming from matched pricing between buy and sell. So the day trade records are one of the discrete observation probabilities. The thesis is picking up the discrete HMM to experiment.

An HMM is a Markov chain and a double-layer random probability system, where each state generates an observation. Only see the observations, and the goal is to infer the hidden state sequence. HMMs are very useful for time-series modeling, since the discrete state-space can be used to approximate many non-linear, non-Gaussian systems. The hidden layer cannot be observation directly. But the hidden layer can be observed from the past random process output series sets. It is mean that the Markov chain includes the hidden layer and observation output layer.

In the thesis, the HMM is assumed that the day trade signal was produced status series (hidden layer) by a random process. Then produce an observation sequence by the status series and the other random process. The generally HMM is a Left-Right Hidden Markov Model. The HMM's architecture is a double stochastic process. This is illustrated in Fig. 3.1.

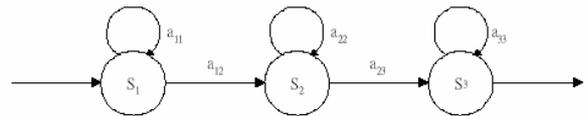


Fig 3.1 the three status Left-Right HMM

However the un-observed layer is a finite set markov chain. Its state probability distribution and states transaction are decided on between the state initial probability vector and state transition probability matrix. But the observed layer is the output of the output layer, which based on each probability distribution.

In theory, the HMM can be a multi layer. Although the result of the multi layer Markov chain is better then the single layer Markov chain. But in opposition, the model is more complex and operation.

However, the work apply the HMM into stock forecast recognition domain. It have to resolve some problem first as the below. (1)How to split each signal? (2)How to like the state sequence? (3)How much is the each status probability?(4)How to detect the next status?

About the problem, the first three problems are belonging to tanning problem. The (4) problem is the recognition process. The (1) belongs to the HMM pre-process problem. The (2) (3) belong to the building the HMM problem. The (4) is the short path problem. In the speech recognition domain, the popular problem is the Vitergbi algorithm.

#### 3.2 HMM Parameter

The HMM consisted of a triple observed probability parameters(A,B, $\pi$ ). So the mathematical model of HMM can be represented to $\lambda=(A, B,\pi)$ .

Each probability in the state transition matrix and in the confusion matrix is time independent - that is, the matrices do not change in time as the system evolves. In practice, this is one of the most unrealistic assumptions of Markov models about real processes. So the  $\lambda$  is the Markov Model. In order to define an HMM completely, following elements are needed.

In order to define an HMM completely, following elements are needed.

- . The number of states of the model, N.
- . The number of observation symbols in the alphabet, M. If the observations are continuous then M is infinite.
- . A set of state transition probabilities  $A = \{a_{ij}\}$ .

$$a_{ij} = p\{q_{t+1} = j | q_t = i\}, 1 \leq i, j \leq N \quad \text{where } q_t \text{ denotes the current state.}$$

Transition probabilities should satisfy the normal stochastic constraints,

$$a_{ij} \geq 0, \quad 1 \leq i, j \leq N \quad (3-2-1)$$

$$\text{and } \sum_{j=1}^N a_{ij} \geq 0, \quad 1 \leq i, j \leq N \quad (3-2-2)$$

- . A probability distribution in each of the states  $B = \{b_j(k)\}$

$$b_j(k) = p\{a_t = v_k | q_t = j\}, 1 \leq j \leq N, 1 \leq k \leq N \quad (3-2-3)$$

Where  $V_k$  denotes the  $k_{th}$  observation symbol in the alphabet and  $O_k$  the current parameter vector.

. Following stochastic constraints must be satisfied.

$$b_j(k) \geq 0, \quad 1 \leq j \leq N, 1 \leq k \leq M \quad (3-2-4)$$

$$\text{and } \sum_{j=1}^N b_j(k) = 1, \quad 1 \leq k \leq N \quad (3-2-5)$$

. The initial state distribution,  $\pi = \{\pi_i\}$

Where,  $\pi_i = p\{q_t = i\}, 1 \leq i \leq N$

Therefore function can use the compact notation

$$\lambda = \{A, B, \pi\} \quad (3-2-6)$$

to denote an HMM with discrete probability distributions.

### 3.3 Vector quantification

In this paper, the recognition system must to do a characteristic value first. [29] Otherwise the system will have a very complex calculate and data. So the vector quantification will calculates the classification by the similar classes. But the general quantification will level down the recognition rate. So this work will apply the vector quantification to do the pre-process.

The code book is been produced by the vector quantification of all stock day trade training data.. The vector quantification will been selected from the stock day trade traing data by the geometric distance clustering. The clustering will group by the closing group. Then it will find out the must representative vector ( A mean of the culster) to do the code word. Ex: Assuming that the two vector quantification are

$$X = [x_1, x_2, \dots, x_n]^T \quad (3-3-1)$$

and

$$Y = [y_1, y_2, \dots, y_n]^T \quad (3-3-2)$$

so the distance define is as below

$$d(X, Y) = \sqrt{\sum_{i=1}^n [x_i - y_i]^2} \quad (3-3-3)$$

This work will need N vector quantification to produce M code word. The population is the K-mean Clustering algorithm. The algorithm lists as below steps.

Step 1: Select an initial partition with K clusters

¢ An initial partition can be formed by first specifying a set of K seed points which can be the first K patterns or K patterns chosen randomly from the pattern matrix

¢ Different initial partitions can lead to different final clustering because algorithms based on square-error can converge to local minima. This is especially true if the clusters are not separated well.

Step 2: Generate a new partition by assigning each pattern to its closest cluster center.

Step 3: Computer new cluster centers as the centroid of clusters

¢ A set of K patterns that are well separated form each other can be obtained by taking the Centerior of the data as the first seed point and selection successive seed points which are at least a certain distance away from the seed points already chosen.

¢ Square-Error

Step 4: Repeat steps 2 and 3 until an optimum value of the criterion function is found

¢ Partitions are updated by reassigning patterns to clusters in an attempt to reduce the square-error.

¢ The Euclidean metric is the most common metric for computing the distance between pattern and a cluster centers

Step 5: Adjusts the number of clusters by merging and splitting existing clusters or by removing small, or outlier, clusters.

¢ Some clustering algorithms can create new clusters or merge existing clusters if certain conditions are met.

### 3.4 Building Hidden Markov Model

In this research, the stock day trade records will be representated vector. pre-process. So the each day will be transfed to the vector series. It represents the each day vector quantification code book. Then the system can forecast the closing pric by the code book seraching.

But the system must been trained the history day trade data before forecast. The training process can get the each model prameter  $\lambda_1, \lambda_2, \dots, \lambda_v$ . Assuming that the  $\lambda$  is known number and the  $O = \{o_1, o_2, \dots, o_T\}$  is the output vector quantification series ( $T = \text{length}$ ). The system will generate the  $q = \{q_1, q_2, \dots, q_T\}$  which is the input vector quantification series. So the probability is as below.

$$P\left(\frac{O}{\lambda}\right) = \sum_q p(O, \lambda) = \sum_{q_1, q_2, \dots, q_T} 1 \cdot b_{q_1}(o_1) a_{q_1 q_2} b_{q_2}(o_2) \dots a_{q_{T-1} q_T} b_{q_T}(o_T)$$

To assume that the HMM have N status, and the HMM can transfer from any one state to anothers. So the status transfer series have  $N^T$ . If the T is very big, the system will have very heavy Big-O. So the probability of the HMM vector quantification series can calcuate form the Forward procedure and Backward procedure.

#### 3.4.1 Forward procedure

Definition: In t time points, there are status in the i status.

And the observed probability is the  $O_1, O_2, \dots, O_t$ , and

the probability of the series is  $\alpha_t(i)$ .

$$\alpha_t(i) = P(O_1 O_2 \dots O_t, q_t = i | \lambda)$$

$$P(O_1 O_2 \dots O_t, q_t = i | \lambda) = \sum_{i=1}^N P(O_1 O_2 \dots O_t, q_t = i | \lambda) = \sum_{i=1}^N \alpha_t(i)$$

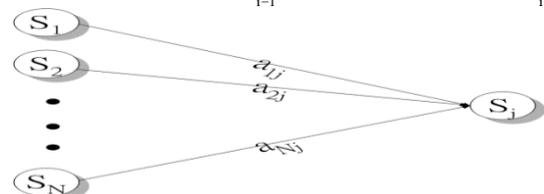


Fig 3.2 The Forward procedure

Algorithm step:

Step 1: Initial setup

$$\alpha_t(i) = \pi_i b_i(O_t), 1 \leq i \leq N$$

Step 2: Recursive

$$\alpha_{t+1}(j) = \sum_{i=1}^N \alpha_t(i) a_{ij} b_j(O_{t+1}), \quad 1 \leq j \leq N, \quad t = 1, \dots, T-1$$

Step 3: Final

$$P\left(\frac{O}{\lambda}\right) = \sum_{i=1}^N \alpha_T(i)$$

### 3.4.2 Backward procedure

Definition: In  $t$  time points, there are  $\lambda$  in the  $i$  status.

And the observed probability is the  $O_{t+1}, O_{t+2}, \dots, O_T$

from  $t+1$  to  $T$ , and the probability of the series is  $\beta_t(i)$ .

$$\beta_t(i) = P(O_{t+1}, O_{t+2}, \dots, O_T, q_t = i | \lambda)$$

$$P(O_{t+1}, O_{t+2}, \dots, O_T, q_t = i | \lambda) = \sum_{k=1}^N P(O_{t+1}, O_{t+2}, \dots, O_T, q_t = i | k) = \sum_{k=1}^N \alpha_T(k)$$

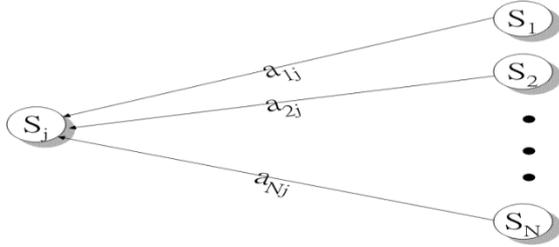


Fig 3.3 The Backward procedure

Algorithm step:

Step 1: Initial setup

$$\beta_T(i) = 1, 1 \leq i \leq N$$

Step 2: Recursive

$$\beta_t(i) = \sum_{j=1}^N a_{ij} b_j(O_{t+1}) \beta_{t+1}(j), \quad t = T-1, T-2, \dots, 1, \quad 1 \leq i \leq N$$

Step 3: Final

$$P\left(\frac{O}{\lambda}\right) = \sum_{i=1}^N \beta_1(i)$$

### 3.5 Estimate the HMM

One great advantage of HMMs is that they can be estimated from sequences, without having to align the sequences first. The sequences used to estimate or train the model are called the training sequences, and any reserved sequences used to evaluate the model are called the test sequences. The model estimation is done with the forward-backward algorithm, also known as the Baum-Welch algorithm, which is described in [4]. It is an iterative algorithm that maximizes the likelihood of the training sequences. So assuming that two vector

quantifications  $P(O/\lambda), P(O/\bar{\lambda})$  to represent the likelihood of  $O$ . Then have the  $P(O/\bar{\lambda}) \geq P(O/\lambda)$  relation between the two vector quantifications. Then use the substitution methods to find out the new parameter  $\bar{\lambda}$ .

Step 1: In  $t$  time points, there  $\lambda$  transfer from the  $i$  status to  $j$  status. The  $\lambda$  probability is  $\zeta_t(i, j)$ .

$$\begin{aligned} \zeta_t(i, j) &= P(q_t = i, q_{t+1} = j | O, \lambda) \\ &= \frac{P(q_t = i, q_{t+1} = j, O | \lambda)}{P(O/\lambda)} \\ &= \frac{\alpha_t(i) a_{ij} b_j(O_{t+1}) \beta_{t+1}(j)}{P(O/\lambda)} \\ &= \frac{\alpha_t(i) a_{ij} b_j(O_{t+1}) \beta_{t+1}(j)}{\sum_{i=1}^N \sum_{j=1}^N \alpha_t(i) a_{ij} b_j(O_{t+1}) \beta_{t+1}(j)} \end{aligned}$$

Step 2: In  $t$  time points, there  $\lambda$  transfer from the  $i$  status to  $i$  status. The  $\lambda$  probability is  $\gamma_t(i)$ .

$$\begin{aligned} \gamma_t(i) &= \sum_{j=1}^N \zeta_t(i, j) \\ &= \frac{\sum_{j=1}^N \alpha_t(i) a_{ij} b_j(O_{t+1}) \beta_{t+1}(j)}{p(o/\lambda)} \end{aligned}$$

Step 3: The new transfer function will be changed to  $\bar{a}_{ij}$

$$\begin{aligned} \bar{a}_{ij} &= \frac{\sum_{t=1}^{T-1} \zeta_t(i, j)}{\sum_{t=1}^{T-1} \gamma_t(i)} \\ &= \frac{\sum_{t=1}^{T-1} \alpha_t(i) a_{ij} b_j(O_{t+1}) \beta_{t+1}(j)}{\sum_{t=1}^{T-1} \sum_{j=1}^N \alpha_t(i) a_{ij} b_j(O_{t+1}) \beta_{t+1}(j)} \\ &= \frac{\sum_{t=1}^T \gamma_t(i)}{\sum_{t=1}^T \gamma_t(j)} \\ \bar{b}_{ij} &= \frac{\sum_{t=1}^{s.t. O_t = v_k} \zeta_t(i, j)}{\sum_{t=1}^T \gamma_t(j)} \\ &= \frac{\sum_{t=1}^T \sum_{j=1}^N \alpha_t(i) a_{ij} b_j(O_{t+1}) \beta_{t+1}(j)}{\sum_{t=1}^T \sum_{j=1}^N \alpha_t(i) a_{ij} b_j(O_{t+1}) \beta_{t+1}(j)} \end{aligned}$$

Step 4:  $\alpha \beta$  scaling

$$\alpha_t(i) a_{ij} b_j(O_{t+1}) = \frac{\alpha_t(i)}{\prod_{r=1}^T c_r} a_{ij} b_j(O_{t+1}) \frac{\tilde{\beta}_{t+1}(j)}{\prod_{r=t+1}^T c_r}$$

$$= \frac{\alpha_t(i) a_{ij} b_j(O_{t+1}) \tilde{\beta}_{t+1}(j)}{\prod_{r=t+1}^T c_r}$$

Step 5: So the  $\alpha_{ij}, \beta_j(k)$  changed to.

$$\alpha_{ij} = \frac{\sum_{t=1}^{T-1} \alpha_t(i) a_{ij} b_j(O_{t+1}) \tilde{\beta}_{t+1}(j)}{\sum_{t=1}^{T-1} \sum_{j=1}^N \alpha_t(i) a_{ij} b_j(O_{t+1}) \tilde{\beta}_{t+1}(j)}$$

$$\beta_j(k) = \frac{\sum_{t=1}^T \sum_{j=1}^N \alpha_t(i) a_{ij} b_j(O_{t+1}) \tilde{\beta}_{t+1}(j)}{\sum_{t=1}^T \sum_{j=1}^N \alpha_t(i) a_{ij} b_j(O_{t+1}) \tilde{\beta}_{t+1}(j)}$$

### 3.6 Viterbi algorithm

Summary pervious process, this work will have a very complex algorithm to find out the correct  $P(O_1 O_2 \dots O_T | M)$ . So the Viterbi algorithm is been used to find out status transfer series by the stock day trade vector quantification. So the algorithm can closing the  $P(O_1 O_2 \dots O_T | M)$  in the optomation algorithm.[12]

Assuming that the vector quantification is as below.

$$\text{Vector quantification: } O = (O_1 O_2 \dots O_T) \quad (3-6-1)$$

This initializes the probability calculations by taking the product of the initial hidden state probabilities with the associated observation probabilities. The max probability is as below.

$$\delta_t(i) = \max_{q_1, q_2, \dots, q_t} P(q_1, q_2, \dots, q_{t-1}, q_t = i, O | \lambda) \quad (3-6-2)$$

According to the recusrive algorithm, So the max probability is as below during the status j at the time point t+1.

$$\delta_{t+1}(j) = [\max_i \delta_t(i) a_{ij}] \cdot b_j(O_{t+1}) \quad (3-6-3)$$

Step 1: Formal definition of algorithm

The algorithm may be summarized formally as:

$$\delta_1(i) = \pi_i b_i(O_1), 1 \leq i \leq N \quad (3-6-4)$$

$$\varphi_1(i) = 0 \quad (3-6-5)$$

Step 2: Recursive

$$\delta_t(i) = \max_{1 \leq j \leq N} \delta_{t-1}(j) a_{ji} b_i(O_t), 2 \leq t \leq T, 1 \leq j \leq N \quad (3-6-6)$$

$$\Psi_t(j) = \arg \max_{1 \leq i \leq N} [\delta_{t-1}(i) a_{ij}], 2 \leq t \leq T, 1 \leq j \leq N \quad (3-6-7)$$

Step 3: End criteria

$$P^* = \max_{1 \leq i \leq N} [\delta_T(i)] \quad (3-6-8)$$

$$q_T^* = \arg \max_{1 \leq i \leq N} [\delta_T(i)] \quad (3-6-9)$$

Step 4: Path look back

$$q_t^* = \Psi_{t+1}(q_{t+1}^*), t = T-1, T-2, \dots, 1 \quad (3-6-10)$$

Symbol define:

$\delta_t(i)$  : The path have the max probability at time point t.

$\Psi_t(i)$  : The satus is that before current status.

$P^*$  : The result is that be calculated by Viterbi algorithm.

$q^*$  : It is the optimal status time series.

$(q_1^*, q_2^*, \dots, q_T^*)$

Summarized pervious, the Viterbi algorithm is follow the initial probability  $\delta_t(i)$ . Then it can obtain a max probability series by rescursive algorithm.(3-6-8) The Viterbi algorithm can obtain the max probability status time series. (3-6-10). So the algorithm can reduce the algorithm search time. This is illustrated in Fig. 3.4.

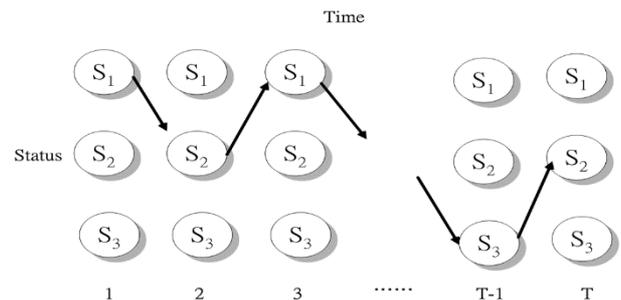


Fig. 3.4 The optimal algorithm of the Viterbi algorithm

## 4. Implementation

### 4.1 Research scope

This paper will build a HMM architecture to forecast the TAIFEX futures (TX) closing price by the previous training. The data source is come from the TEJ database. This paper is forecasting the TAIFEX futures (TX) closing price. So this paper will to build an each five minutes day trade records first. This paper will to forecast the TAIFEX futures (TX) behavior in one day.

The source data of this work is as below list.

- (1)The records of the each five minutes TAIFEX futures
- (2)The volume of the each five minutes
- (3)The high price of the each five minutes
- (4)The low price of the each five minutes
- (5)The opening price
- (6)The closing price

The source data has 41439 records of the each five minutes TAIFX futures (TX). The source data can transfer to total 866 days trade history records from 21, July, 1998

to 20, February, 2002. The training time is from 21, July, 1998 to 21, July, 2000. So the training data has 20946 records. (Table 4.1) The simulation time is from 24, July 2001 to 20, February 2002. So the simulation data has 20493 records.

#### 4.2 Simulation architecture

In this section, this work will to introduce the HMM method in detail that is because the model is more complex than the other two methods. The simulation architecture is illustrated in Fig. 4.1.

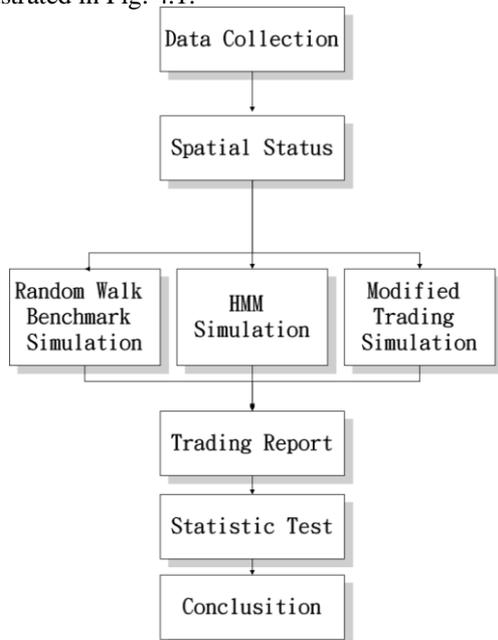


Fig. 4.1. Simulation Architecture

#### 4.3 Simulation model

In this section, this paper will to introduce the two simulation methods in the next two small sections. The first section is the benchmark method - Random Walk method. The second section is the method - Modified Trading method. The next section is the HMM. This work will to introduce the HMM method in detail that is because the model is more complex than the other two methods.

##### 4.3.1 Random Walk model

Robbers publish this Random Walk model is in 1967. The model has not intercept item. So the revenue of the forecasting mean( $\mu$ ) should be zero. The mean is that the random variable is the zero expected value. The Random Walk model is sampling form the simplex with probability density proportional to

$$Z = \frac{x - \mu}{\sigma}$$

$$f(Z) = \frac{1}{\sqrt{2\pi}} e^{-\frac{z^2}{2}}; -\infty < Z < \infty$$

$$E(z) = E\left(\frac{x - \mu}{\sigma}\right) = \frac{1}{\sigma} E(x - \mu) = 0$$

The model is the weak-form efficient market hypothesis in the financial forecast domain. This work will compare HMM model to this financial benchmark model.

##### 4.3.2 Modified Trading model

The Modified Trading Method applies to all eight Full and Partial Gap scenarios above. The only difference is instead of waiting until the price above the high or below the low for a short. The method has fast trade execution systems. Since heavy volume trading can experience quick reversals, mental stops are usually used instead of hard stops. In simple terms, the Gap Trading Strategies are a rigorously defined trading system that uses specific criteria to enter and exit. Trailing stops are defined to limit loss and protect profits. The simplest method is also being applied into Taiwan. All eight of the Gap Trading Strategies can be applied to day trade.

About the method is consists of 3 time points. That is the 10:30, 10:35, and 10:45 respectively. But it is applied in the Taiwan stock market. The method should be mapping into the 9:00, 9:05, and 9:10. That the intrados chart is graphed slightly differently, showing a composite of the trades occurring every 5 minutes. The figure is illustrated in Fig. 4.2. The figure is that Akamai Technologies stock each 5 minutes char. Although a trade-by-trade charting tool would show the exact bid and ask spread, this tutorial will refer to the left-side horizontal line of each bar as the open, and the right side horizontal bar as the close of each trade.

#### 4.4 HMM model

##### 4.4.1 HMM template training model

This work stock day trade training architecture has two major units. One is the parameter analysis unit and the other is the HMM template unit. The architecture is illustrated in Fig. 4.3

###### (1) Parameter Analysis unit

This work will sample the stock day trade time series. This work will to record the all day trade time series signal. Then scattered about each 5 minutes. So separated the each 5 minutes. So the original forecasting architecture has two major units. One is the parameter analysis unit and the other is the HMM database unit.

###### (2) HMM template database unit

This unit will store the stock day trade time series. The database purpose is storing the each day trade time series for HMM template model. The architecture is illustrated in Fig. 4.3

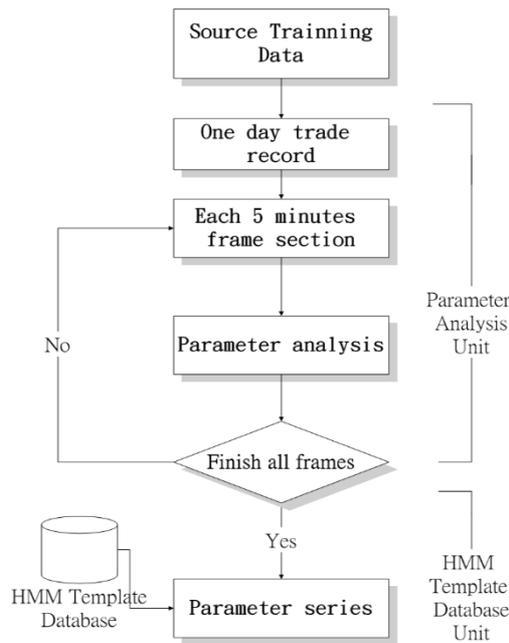


Fig. 4.3. The HMM training architecture

## 5. Experiment

### 5.1 Research scope boldface

The source data has 41439 records of the each 5 minutes TAIFX futures (TX). The source data can transfer to total 866 days trade history records from 21, July, 1998 to 20, February, 2002. The training time is from 21, July, 1998 to 21, July, 2000. So the training data has 20946 records and 538 days. The simulation time is from 22, July 2001 to 20, February 2002. So the simulation data has 20493 records and 326 days. So the experiment result will have 326 days trade record. This work will follow each experiment simulation report to do a comprehensive survey.

### 5.2 Random Walk experiment

The Random Walk method simulation follows previous data scope to simulation. Then the method result is the below table 5.1. The result is for statistic test. So the result will follow the below three functions 5-2-1, 5-2-2, and 5-2-3 to calculate result. The simulation time is from 22, July 2001 to 20, February 2002.

$$\text{Sum} = \sum_{\text{Day}=1}^n \text{Re sult} \quad (5-2-1)$$

$$\mu = \frac{\sum_{\text{Day}=1}^n \text{Re sult}}{n} \quad (5-2-2)$$

$$\text{Variance} = \sigma^2 = \frac{\sum_{\text{Day}=1}^n (\text{Result} - \mu)^2}{n} \quad (5-2-3)$$

Simulation Result	
Method	RW
Sum	-3435
No deal	0
Success	142
Fail	184
Mean	-10.53680982
Var	19635.98484
N	326
Max	412
Min	-456

Table 5.1 Random Walk simulations Result

### 5.3 Modified Trading experiment

The Modified Trading method simulation is follow previous data scope to simulation. Then the method result is the below table 5.2. The result is for statistic test. So the result will follow the previous three functions 5-2-1, 5-2-2, and 5-2-3 to calculate result. The simulation time is from 22, July 2001 to 20, February 2002.

Simulation Result	
Method	MT
Sum	3611
No deal	125
Success	107
Fail	94
Mean	11.07668712
Var	12873.59841
N	326
Max	456
Min	-363

Table 5.2 The Modified Trading simulations Result

### 5.4 HMM experiment

This work obtained a TAIFEX futures (TX) status transfer probability matrix as the Table 5.3. In the table, the two status (HH and LL) are the maximum of the night status probability matrix. So if the relative high status is occurring in the second time points, then the 3<sup>rd</sup> time point will be relative high status which is 50.1034% of probability.

State Before \ State Now	HH	HN	HL	NH	NN	NL	LH	LN	LL
HH	<b>0.501034</b>	0.253623	0.245343	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
HN	0.000000	0.000000	0.000000	0.342752	0.345230	0.312018	0.000000	0.000000	0.000000
HL	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.352833	0.348325	0.298842
NH	0.405234	0.312751	0.282015	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
NN	0.000000	0.000000	0.000000	0.213502	0.401256	0.385242	0.000000	0.000000	0.000000
NL	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.194253	0.392130	0.413617
LH	0.364223	0.392130	0.243647	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LN	0.000000	0.000000	0.000000	0.214453	0.372223	0.413324	0.000000	0.000000	0.000000
LL	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.186273	0.332130	<b>0.481597</b>

Table 5.3 TX status transfer probability matrix

The HMM method simulation is follow previous data scope to simulation. Then the method result is the below table 5.4. The result is for statistic test. So the result will follow the previous three functions 5-2-1, 5-2-2, and 5-2-3 to calculate result. The simulation time is from 22, July 2001 to 20, February 2002.

Simulation Result	
Method	HMM
Sum	8488
No deal	112
Success	126
Fail	88
Mean	26.03680982
Var	12962.5692
N	326
Max	411
Min	-412

Table 5.4 The HMM simulations Result

### 5.5 Statistic tests

This work obtained a result of the TAIEX futures (TX) each simulation methods. The result is been ordered into the table 5.5. So this section will to do some statistic test to verify the result. This work will use the difference variance tests and the difference of means tests.

Simulation Result			
Method	RW	MT	HMM
Sum	-3435	3611	8488
No deal	0	125	112
Success	142	107	126
Fail	184	94	88
Mean	-10.53680982	11.07668712	26.03680982
Var	19635.98484	12873.59841	12962.5692
N	326	326	326
Max	412	456	411
Min	-456	-363	-412

Table 5.5 The each method Result

#### (1) Difference variance tests:

For match pair, the output generated includes the value of the F statistic for the null hypothesis that the variance of the differences is equal to zero. In the other words, that the variance of the one simulation result will beater then the other. This work will use the Right-tailed test to verify. So the test calculates as below.

$$H_0 : \sigma^2_{MT} \geq \sigma^2_{RW} \quad (5-4-1)$$

$$H_1 : \sigma^2_{MT} < \sigma^2_{RW} \quad (5-4-2)$$

$$F^0 = \frac{\hat{S}^2_{MT}}{\hat{S}^2_{RW}} = \frac{12873.59841}{19638.98484} = 0.65561 < F_{0.05}(\infty, \infty) \approx 1 \quad (5-4-3)$$

So according to the staistic difference of means tests,

this work must to reject  $H_0$ . In other words, the tests obtained the significance result of this, which the Modified Trading method is beater then the Random Walk method.

#### (2) Difference of means tests

For match pair, the output generated includes the value of the T statistic for the null hypothesis that the mean of the differences is equal to zero. In the other words, that the mean of the one simulation result will beater then the other. This work will use the Left-tailed test to verify. So the test calculates as below.

$$H_0 : \mu_{RW} \geq \mu_{MT} \quad (5-4-4)$$

$$H_1 : \mu_{RW} < \mu_{MT} \quad (5-4-5)$$

$$t^0 = \frac{\bar{d} - 0}{\frac{\hat{S}_d}{\sqrt{n}}} = \frac{-21.635}{\frac{113.636}{18.055}} = -3.43 < t_{(0.05; 326)} = -1.645 \quad (5-4-6)$$

So according to the staistic difference of means tests, this work must to reject  $H_0$ . In other words, the tests obtained the significance result of this, which the Modified Trading method is beater then the Random Walk method.

$$H_0 : \mu_{MT} \geq \mu_{HMM} \quad (5-4-7)$$

$$H_1 : \mu_{HMM} < \mu_{MT} \quad (5-4-8)$$

$$t^0 = \frac{\bar{d} - 0}{\frac{\hat{S}_d}{\sqrt{n}}} = \frac{-14.96}{\frac{114.028}{18.055}} = -2.368 < t_{(0.05; 326)} = -1.645 \quad (5-4-9)$$

So according to the staistic difference of means tests, this work must to reject  $H_0$ . In other words, the tests obtained the significance result of this, which the HMM method is bater then the Modified Trading method.

### 5.6 Time series analysis of regression

The Time Series Forecast is determined by calculating a linear regression trend line using the Least Squares method. The least squares fit technique fits a trend line to the data in the chart by minimizing the distance between the data points and the linear regression trend line. The HMM method have the best revenue. But the result can't be sure the revenue will very good in future. So the analysis of regression can make sure the result. So the Least Squares method calculate as below.

Unit : day

Origin : 2000/7/20

$$Y_T = a + bX \quad (5-5-10)$$

$$a = \frac{\left| \begin{matrix} \sum Y & \sum X \\ \sum XY & \sum X^2 \end{matrix} \right|}{\left| \begin{matrix} n & \sum X \\ \sum X & \sum X^2 \end{matrix} \right|} = \frac{\sum Y \sum X - \sum X \sum XY}{n \sum X^2 - (\sum X)^2} = 44.01153 \quad (5-5-12)$$

$$b = \frac{\left| \begin{matrix} n & \sum Y \\ \sum X & \sum XY \end{matrix} \right|}{\left| \begin{matrix} n & \sum X \\ \sum X & \sum X^2 \end{matrix} \right|} = \frac{n \sum XY - \sum X \sum Y}{n \sum X^2 - (\sum X)^2} = 0.019704 \quad (5-5-11)$$

So from the slope of the HMM method will have a plus revenue in the long-term trend.

### 5.7 Statistic Test conclusions

Summarized the previous section, this work have some conclusion. That HMM have the best revenue. Because the HMM method is bater then the Modified Trading method and the Modified Trading method is bater then the Random Walk method.

The HMM method have the best revenue. But in the risk view, the HMM just only have the same risk with the Modified Trading method. So this work will arrange the relation in the below table 5.7 and table 5.8.

	RW	MT	HMM
RW		No	No
MT	Yes		No
HMM	Yes	Yes	

Table 5.7 The each method revenue compare

	RW	MT	HMM
RW		No	No
MT	Yes		Equal
HMM	Yes	Equal	

Table 5.8 The each method risk compare

## 6. Conclusion

### 6.1 Thesis Conclusion

The HMM model is a very population model in the speech recognition domain. This work approve the HMM model have a very well forecasting in the stock recognition domain. Especially, the TAIFEX futures from the opening price recognized the closing price.

However, this work has a very conspicuous by the statistics testing of significance. The HMM model is beater then Random Walk model and the Modified Trading model. But this work only has a blemish in an otherwise perfect thing, which the risk is same with the Modified Trading model. Additionally, this work approve that long-term trend of the HMM model will be a positive slope line. In other words, the revenue will be increasing.

In clusion, the HMM model is a feasible and stable model in the TAIFEX futures day trading. The HMM model will have positive revenue in the long-term time series.

### 6.2 Discussion

This work has a very conspicuous result by the statistics testing of significance and the approving of the time series method. But this section will draw a conclusion to collect

factors of back. This work has some conclusions as below list.

- (1)The HMM model is based on the traditional Bayes' theorem. So the model can calculate the probability of the each status delivery.
- (2) The HMM model can recognize the complex speech domain. So this method can easy to recognize three status of the stock market even to forecast the future.
- (3) The TAIFEX futures have similar characters with the speech frequency.
- (4) The pass papers just apply the HMM model in American stock market and those papers just apply into the next day trading.
- (5) The TAIFEX futures have some special characters just in Taiwan.

### 6.3 Future directions

Even if, this work has very conspicuous result. But the HMM model have a risk just like the Modified Trading method. So in the future, this feet of clay can be fixed by the invest strategy just like some speech recognition system be fixed some defect s form the system architecture. So this work has some suggestions as below list.

- (1) This work just applies the model in the TAIFEX future. In the future, the experiment can apply into the other stocks.
- (2) The HMM model has a risk. In the future, the experiment can try to find out the optimal invest strategy to evade the risk.
- (3) The HMM model is been applied into the neural network in the pass patents. In the future, the experiment can try to lead in the neural network.
- (4) This works just splitter three statuses. In the future, the experiment can try to use the really K-means algorithm. In the other words, the experiment can try to use the binary splitter status.
- (5) This work just used one Lot to order the TAIFEX future. In the future, the experiment can try to find out the optimal number of Lot.
- (6)This work just applied the method in the front process. In the future, the experiment can try into the rear process. Just like search algorithm or strategy decision.

## References

- [1].Anderson, W.N. Jr., Kleindorfer, G.B., Kleindorfer, P.R., Woodroffe, M.B. "Consistent estimates of the parameters of a linear system." Ann.Math. Stat.40, 2064-2075, 1969
- [2].Adlar Jeewook Kim, " Input/Output Hidden Markov Models for Modeling Stock Order Flows", M.I.T. A.I. Lab Tech. Rep., No. 1370, Jan,2001
- [3].A. Waibel, T. Hanazawa, G. Hinton, K. Shikano, and K. Lang,"Phoneme recognition using time-delay neural networks," IEEE Trans. Acoust., Speech, Signal Processing, vol. 37,pp.328-339,1989

- [4].A.Poritz, "Hidden Markov Models: A guided tour," in Proc. Int. Conf. Acoust., Speech, Signal Processing, pp.7-13,1988
- [5].Acero A., Stern R.M., "Environmental robustness in automatic speech recognition," Proc ICASSp-90, pp 849-952, Albuquerque, NM,1990
- [6].Admati, A.R. and P. Pfleiderer,"The Theory of Intraday Patterns: Volume and Price Variability," Review of Financial Studies, vol.1.pp.3-40,1988
- [7].Bahl L.R., Jelinek F., "A maximum likelihood approach to continuous speech recognition," IEEE Trans. Pattern Analysis Machine Intelligence,5, ,1983
- [8].Bahl L.R., Brown P.F., De Souza P.V., Mercer R.L., "A tree-based statistical language model for natural language speech recognition," IEEE Trans. On Acoustics Speech Signal Process, 37, No. 7.pp.1001-1008,1989
- [9].Bollerslev, T., "On the Correlation Structure for the Generalised Autoregressive Conditional Heteroskedastic Process," Journal of Time Series Analysis, 9, pp. 121-32. 1988
- [10].Balasubramanian V., "Equivalence and reduction of Hidden Markov Models", M.I.T. A.I. Lab Tech. Rep., No. 1370, Jan,1993
- [11]. Bo-Sung Kim, Bok-Gue Park, Jun-Dong Cho, Young-Hoon Chang, "Low Power Viterbi Search Architecture using Inverse Hidden Markov Model,"pp. 724 -732.,2000
- [12].Claudio Becchetti and L. P. Ricotti, "Speech Recognition Theory and C++ Implementation," John Wiley & Sons Ltd, 1999.
- [13].Roberts, H., "Statistical versus Clinical Prediction of the Stock Market," unpublished manuscript, Center for Research in Security Prices, University of Chicago,May, 1967
- [14].Robinson, P., "Time Series with Strong Dependence," in C. A. Sims (ed.), Advance sin Econometrics: Sixth World Congress, Vol. I, Cambridge University Press, pp. 47-95.,1994
- [15].Turner, C. M. , R. Startz and C. R. Nelson, "A Markov model of heteroscedasticity, risk and learning in the stock market," Journal of Financial Economics, 25, pp. 3-22.,1989
- [16].Steinhaus, S. "Comparison of mathematical programs for data analysis," University of Frankfurt, Germany, <http://www.informatik.uni-frankfurt.de/> , 1999
- [17].Starck, J.L., Murtagh, F., and A. Bijaoui Image and Data Analysis: The Multiscale Approach, Cambridge University Press,1998
- [18]. Chen, S. H. and C. W. Tan "Estimating the Complexity Function of Financial Time Series," The Journal of Management and Economics, Oct.-Nov., Vol. 3.,1999
- [19].Thomas Hellstrom, Kenneth, Kolmstrm,"Predictable Patterns in Stock Returns" Department of Mathematics and Physics, Malardalen University Press,1998
- [20].Bagella M., Becchetti, L., Carpentieri, A., "The first shall be last. Do contraian strategy premia violate financial market efficiency," mimeo,1988
- [21].D. Easley, N. Kiefer, and M. O'Hara. The information content of the trading process. Journal of Empirical Finance,vol., 4 pp.159-186, 1997.
- [22].L. Rabiner." A tutorial on hidden markov models and selected applications in speech recognition.," In Proceeding of IEEE, Vol. 77, No. 2, pages 257-286, 1989.
- [23].L. R. Rabiner, "A tutorial on hidden Markov models and selected applications in speech recognition," AT&T Bell Syst. Tech. Journal, vol. 62, no. 4, April,1983
- [24].L.B. Jackson, Digital Filters and Signal Processing with MATALAB Exercises, Kluwer Academic Publishers, 1995.
- [25].Y. Bengio. "Markovian models for sequential data," Neural Computing Surveys, 2:129-162, 1999.
- [26].Y. Bengio and P. Frasconi."Input/output hmms for sequence processing," IEEE Transactions on Neural Networks, 7(5) pp.1231-1249, 1996.
- [27].J.G. Wilpon, et al., "Automatic Recognition of Keyword in Unconstrained Speech Using Hidden Markov Models," IEEE ASSP Magazine, Vol. 38, pp. 1870-1878, 1990.
- [28].J. R. Deller, "Discrete-Time Processing of Speech Signals," Macmillan,1993.
- [29]. J.G. Bergh, F.K. Soong, and L.R. Rabiner, "Incorporation of Temporal Structure Into a Vector-Quantization-Based Preprocessor for Speaker-Independent, Isolated-Word Recognition," AT & T Technical Journal, Vol. 64, No. 5, May-June 1985.
- [30]. G. Wilpon and L.R. Rabiner, "A Modified K-Means Clustering Algorithm for Use Isolated Word Recognition," IEEE Trans. Acoustics, Speech, and Signal Processing, Vol. 33, No. 3, pp. 587-594, June 1985.
- [31]. L'utkepohl, H.: Introduction to multiple time series analysis. Berlin, Heidelberg, New York.,Springer 1991
- [32]. Liptser, R.S., Shirayayev, A.N.: Statistics of random processes. Vols. I and II. Berlin, Heidelberg, New York: Springer 1977
- [33].Kaas, Robert E and Adrian E. Raftery."Bayes Factors," Technical Report 254,Department of Statistics, University of Washington., 1995
- [34].Lin, Tsungan and Bill G. Horne. "Learning Long-Term Dependencies in NARXRecurrent Neural Networks." 1996 IEEE Conference on Neural Networks. pp. 1329-1338,1996
- [35]. Neal, Radford M. "Monte Carlo implementation of Gaussian process models for Bayesian regression and classification," Technical Report No. 9702, Dept. Of Statistics, University of Toronto. ftp://ftp.cs.toronto.edu/pub/radford, 1997

[36]. Valtchev, V., S. Kapadia, S. J. Young. "Recurrent Input Transformation for Hidden Markov Models." Cambridge University Engineering Department Technical Report.,1995

# E-Banking in Italy: An Analysis of the Evolution of Prices, Services and Competition Strategies <sup>1</sup>

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## Abstract

There are been many claims that the Internet could represent a “frictionless” and almost perfect market [1]. This belief was particularly evident in that banking industry, where Internet was considered as a source of sustainable competitive advantage for a new generation of banks focused on this sale channel.

E-banking in Italy, ever if it was started later then U.S.A. and other european countries as now reached a fast expersion stage. Most of the banks though whit different timing and structures have developped web-sites to growt customers banking and trading access through Internet. At the same time new competitors not in the banking business have recently entered in the market.

Our research empirically analysed the e-banking services offered by a sample of 54 Italian banks.

We considered as e-banking services all banking services that can be accessed through the Internet.

Data on offered services and their prices were collected on a quarterly base. We analysed the following aspects:

- Trend in services offered on-line to customers;
- Trend in market segmentation and in banks strategies;
- The economics emerging from the competition in on-line banking.

We used these data for testing the hypothesis of “frictionless market”. The obtained results seem to show that the market of e-banking services is very different from early expectations, and that economies of scale and brand remain as important sources of competitive advantage.

## 1 Introduction

One of the most important and innovative aspects of the new set-up of the banking distribution system is the use of virtual channels for distributing financial services, which will certainly represent key factor in the future structing of banking. The new distribution channel have a strong potential impact all aspects the relationship between the customer and the financial broker, which cover from the choice of the broker up to the identification of a specific financial service to the delivery. In spite of the fact that at present stage of the cultural environment, the human contact is not easily replaceable as the foundation of the financial brockering, the virtual channel is likely

appearing as radically innovative instruments for most of the current transactions, in terms of efficiency and convenience [3].

The present paper purpose is to analyse the delivery of financial services and retail banking through Internet.

E-banking in Italy, ever if it was started later then U.S.A. and other european countries as now reached a fast expersion stage. Most of the banks though whit different timing and structures have developped web-sites to growt customers banking and trading access through Internet. At the same time new competitors not in the banking business have recently entered in the market, these new commerce taking advantage of the substantial reduction of the obstacles to the entry in the sector, have developed offers of on-line banking services with the objectives of gaining market shares taking advantage of the synergies they have with their own core business ( i.g. the network of promoters working for on line banks originated from insurance business).

Our analysis has covered a simple of banks and SIM wich offer on-line financial services taking into a count types, completeness and pricing of the services. We have tried to draw a model of this new virtual market including the strategies used and being used by the brokers in order to obtain an entry and describing the new types of banks which are succesfull. The research is focused on the analysis of the offer of retail services for private customers (BtoC) and was aimed at verifying the consistency of the theoretical viewpoint that claimed that the Internet could represent a “frictionless” and almost perfect market. This belief was particularly evident in the banking industry, where Internet was considered as a source of sustainable competitive advantage for a new generation of banks focused on this sale channel, due to the fact that “location” was irrelevant and customers were fully informed of prices and product offerings. Such hypothesis was based on the following (and often untested) facts:

- on-line banks would have had lower operating costs and a wide product portfolio; fully informed customers will recognize these advantages and will switch to these banks;
- it would have been very difficult for incumbent banks to imitate newcomers strategy, loosing profitable customers attracted by newcomers’ services;
- Internet would have divided banking services into

<sup>1</sup>Marco Brugiati and Giuseppe Vironda are gratefully acknowledge for their work in data collection and analysis. The research was funded by the Istituto Superiore Mario Boella.

new segments, with different customers and profit margins;

Competition among newcomers will lead to lower and more homogeneous prices. Our research empirically analysed for a period of 18 months (from December 2000 to June 2002) the e-banking services offered by a sample of 54 Italian banks (they account for about the 80% of Italian banking industry).

The research was limited to the main Italian banking groups as well as to all virtual banks thus covering 60% approx of the total all Italian banking system, using as a ranking criteria the total business value. The term virtual bank describes both the new virtual banks and the spin-off of traditional banks who have chosen a new brand name for the Internet services distribution.

The scenario of the banks considered relevant in the business includes the first 29 Italian banks plus other six banks which are located between the thirty-sixth and the fifty-sixth rank in the ranking by business value and which offer Internet banking services of remarkable innovative type. On the other all virtual banks and SIM operating on-line have been taken into consideration since their number is relatively small.

We considered as e-banking services all banking services that can be accessed through the Internet.

Data on offered services and their prices were collected on a quarterly base. We analysed the following aspects:

- Trend in services offered on-line to customers;
- Trend in market segmentation and in banks strategies;
- The economics emerging from the competition in on-line banking.

## 2 Characterizing Competition in Electronic Markets

A basement computer room at Buy.com [2] headquarters in Aliso Viejo, California holds what some believe is the heart of the new digital economy. Banks of modems dial out over separate ISP accounts, gathering millions of prices for consumers products: books, CDs, videos, computer hardware and software. Specially programmed computers then sift through these prices, identifying the best prices online and helping Buy.com deliver on its promise of having "the lowest price on earth". Buy.com's model seems to represent the economic ideal for frictionless markets: low search costs, strong price competition, low margins, low deadweight loss.

This paper approaches this expectation by exploring aspects of business to consumer electronic commerce markets. Expectations in terms of "frictionless markets" that we tried to test in banking on-line were the following:

- By using the Internet, buyers have perfect information of sellers offering and of higher price elasticity. Price elasticity measures how sensitive consumer demand is to change in price. For commodities, price elasticity may be an important

signal of market efficiency. In efficient markets, consumers are more sensitive to small changes in prices, at least as long as substitute vendors or products exist. Higher price elasticity may result from lower search costs or lower switching costs for Internet consumers. Low buyers switching and search costs will promote price competition among sellers and reduce price dispersion;

- Operating and menu costs are lower for banks that offers only on-line services. Menu costs are the costs retailers incur when making price changes. In a conventional setting, menu costs result primarily from the costs to physically re-label products on shelves. In an electronic market we hypothesize that menu costs should be lower, comprised primarily of the cost to make a single price in a central database
- There will be a new segmentation of the retail banking industry, with the newcomers serving the most profitable part of the market.

Data collection was therefore focused on the evolution of services characteristics, prices level and dispersion, menu costs, market segmentation.

## 3 The Results of the Analysis

We have found that the offer of e-banking is far from what theory expected. More in detail our findings were the following.

### 3.1 Market Segmentation

After a very short period, banks clearly divided their on-line services into three segments, each oriented to a different type of customer:

- on-line upgrade of existing accounts, that allowed customers to access both via the Internet or existing branches the "traditional" accounts. In this case banks' strategy was to allow existing customers to on-line access "traditional" banking services, including trading. In 2001-2002 this segment was the one with the highest growth rate in Italy, and is also gaining market shares in stock trading. The offer of this type of product is in line with the "multi-channel strategy" presently followed by most of the traditional banking institutions. The promotion campaign for this product is generally carried on the branches and marginally on media specifically at the time of the introduction on the market;
- pure on-line accounts, offered mainly by newcomer "virtual" banks, are cash deposits with high interest rates and low prices. These once "virtual" products are now becoming more "physical" by offering the possibility to operate through bank branches. This type of

product is offer by the on-line banks, which are new financial instiution, generally spin-off of traditional banks or insurance company which have elected Internet as their main distribution channel and as a core business. This financial institution considered e-banking channel as an opportunity for obtaining a substantial competitive advantage on the traditional institutions, thanks to the reduction of the huge costs of structure and personal due to the operation of the branches

- pure trading accounts are cash deposits with advanced trading services. This product is obviously the only one offered by all SIM and is addressed to a type of customers whose only interest is to operate on stocks market through Internet. Such product is also offered by some traditional banks that have the objective of specializing their offer for the on-line traders, thus aiming to get reach new customers.

In each segment medium banks developed versioning strategies, by offering a basic (and usually low cost) and an advanced (with more services and high annual fees) version of their accounts. Initially, accounts belonging to the basic version were devoted to customers oriented, firstly, towards banking services. Those belonging to the advanced version were devoted to customers with trading needs.. Nevertheless after 18 months we observed how the distinction between basic and advanced versions is rapidly reducing. On the contrary, large incumbents immediately gave up to versioning by offering standard, low cost and all-included accounts [Fig.1 and 2]

### 3.2 Price Level

We founds that prices of banking services are always lower on-line than in branches. Such saving is mainly due to the lower commissions on share trading, which is three times cheaper on Internet. Transfer cost is also lower, since in most cases money transfer by the Internet are free of charge. Sometimes few trading transactions can generate enough savings on commissions to offset tha yearly cost of internet banking services. Sometimes no charge are applied for a given number of yearly transactions.

Bank size seems to be an important driver in determining prices and number of offered services, since large banks are offering more services and have the lowest prices. This fact contradicts the claim of cost advantages for newcomers and shift focus on the importance of economies of scale and existing customer relationships [Fig.3].

On line banking services show a different perspective. The most renown players are those who offer the overall best terms.

However success depends strictly on a well-know and high reputation brand name. This is evidenced by the market scenarious:

- The higher shares of market belong to the new

players (on line banks and financial services); “the first mover” advantage depends onbeing perceived by the customer as a market leader in the supply of innovative services since the very onset.

- In the case of traditional players, being backed by a well know and established brand name enhances credibility and customer confidence; this is evidence by the substantial market shares obtained in a few months by the quantity of customers acquired over a short period of time by traditional large bank Sanpaolo, as compared with other players already established on the market.

### 3.3 Economics and Strategy

Menu costs are the costs retailers incur when making price change. In a conventional setting menu costs result primarily from the costs to phisically re-label products on shelves.Menu costs are close to zero from a theoretical viewpoint; nevertheless banks found very difficult and costly to include in advertising information about price change different from fees for stock trading and interest rate on deposits;

Although customers have a perfect information from a theoretical viewpoint, they have to deal with information overload caused by banks strategies. On line accounts cost is not generated by early charges only.

- As opposed to other possible instances, the cost of these type of products consists of two elements: the cost of the account or the upgrade package; the fee whose total yearly amount depends on the number of client’s transactions. Such strategies have made the cost structure of accounts (in terms of mix of fixed and variable costs) very complex and difficult to be compared. This aspect strongly affects the ability of customers to find the best account and to move to a new bank, explaining the problems that both newcomers and incumbents are experiencing in attracting new customers.
- Branding and trust remain sources of heterogeneity and competitive advantage;
- Competition is not on prices. Prices did not significantly change in18 months and, more significant, their dispersion slightly increased [Fig.4]

In the same period each type of offered accounts increased the number of additional services [Fig.5].

In terms of competition, what we have observed is that Internet is transforming the retail banking industry in way that is very different from the one expected.

On-line account is becoming a commodity, causing e-banking services to evolve “down-market” to a low margin – high volume business. Initially, competition was based on “price” and “differentiation”. The service was particularly standardised, banks tried to acquire new

customers by reducing more and more the trading commissions for negotiation approaching to zero the costs for the use of the basic banking services. Then, banks reacted, trying to differentiate their products, enriching them with new functions and new services: all players chose an improvement of the trading services and of all the services which supported the trading. These went from the platforms of technical analysis to the tools which operated on derivatives. But, they soon realized that any innovation could be easily imitated by competitors, making products more and more homogeneous. Now, banks are looking for the wholeness of the offer, for an improvement and a development of services also through the enlargement of channels from the call centres integrated with web to wireless systems. The offer of the service is not enough. The future will probably see a further change aimed at the elimination of the “dematerialization” of the relationship with the consumer.

As an effect of product increased homogeneity, after their initial success newcomers lost their momentum and now are serving some sorts of up-market niches (on-line and trading accounts for a small number of sophisticated customers). Incumbents rapidly imitated the behaviour of newcomers and focused on low cost – all included upgrade of existing accounts, including in some cases services that are close to the ones of the trading accounts. According to this strategy, at the moment the largest incumbents are the more competitive in terms of breadth of offered services and have the lowest prices [FIG.6].

The resulting market competition does not seem to be close to what was figured out a couple of years ago. On-line pure player have been pushed to niche segments, and there will be probably no more room for them. Since technology can be easily imitated and requires large investments, it is the ability to effectively manage the relationship with the customer that makes the difference. Large incumbents developed a strategy based on offering on-line services at a very reduced cost in order to progressively convince customers to move to the Internet, in order to reduce cost of the network of branches.

#### 4 Concluding Remarks

In conclusion Internet hasn't full filled the expectations. Even though on one hand the price level obtainable on the virtual market is lower than the true market's (however the difference is small) also on the e-market the spread of prices is extremely wide.

In essence it can be said that the offer of the banks is in line only on the costs factors which are very “visible” such as commissions which have been the focus of the marketing campaign of all institutions. The price spread is due to several factors such as:

- the variety of products. This is in fact main the factor of the spread. Many services can be combined to the accounts or to the “package”, and each bank has its own policies and strategies, It's very hard to find two different accounts that

allow to perform exactly “the same functions in the same manner”;

- the diversified information. It is sensible to assume that the players are not all equally know and that most of the potential customers know only some out of them. The result of such situation is that banks are located in a scarcely competitive scenario, and this fact may justify the spread of prices;
- branding and trust;
- “lock-in effects”. The lock-in effects represents the last exploration to the price spread. Several banks are trying to develop the fidelity of their customers. It is too expensive for a customer in terms of the time required to change the bank.

In addition it was a common thinking that Internet would have been a diminishing factor for the banking system but at the end we can say that even though the strategies adopted by the “incumbent” appear as conservative, they have anyway succeeded in obtaining competitive positions against the new commerce on the e-banking market. Furthermore the fact that all banks have set up a virtual counter and that the virtual banks have not multiplied as expected indicates that the incumbents have been successful in reacting by offering products capable of attracting new customers.

5 Appendix

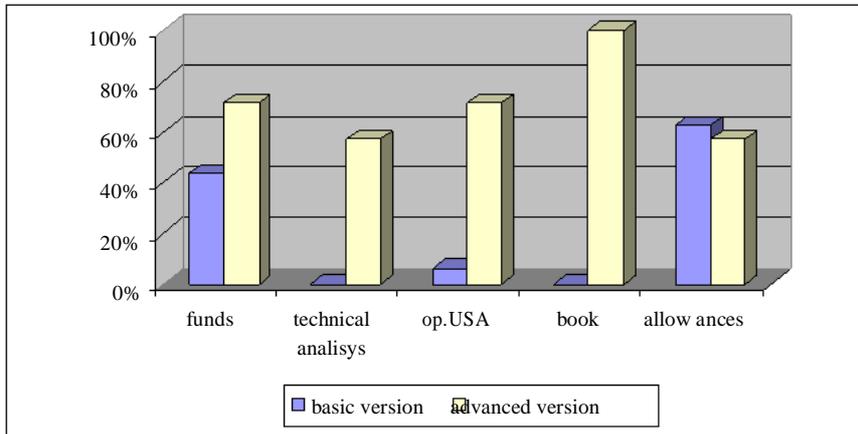


Figure 1. Scheme of the services included in the clusters of the pure on line accounts at December 2000

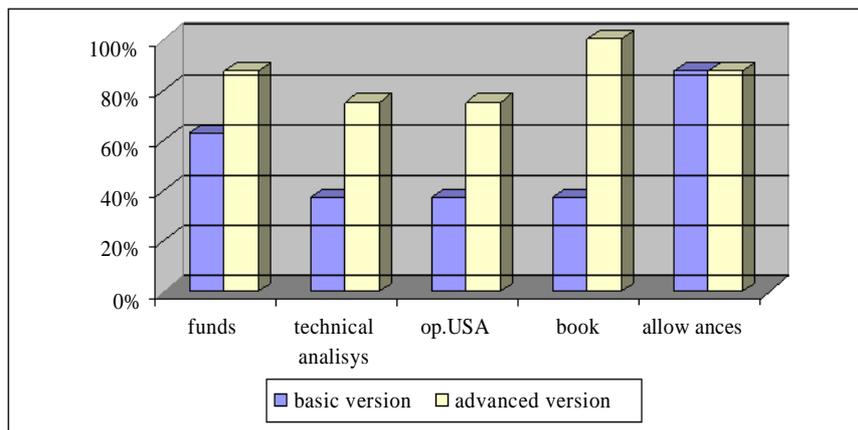


Figure 2. Scheme of the services included in the clusters of the pure on line accounts at June 2002

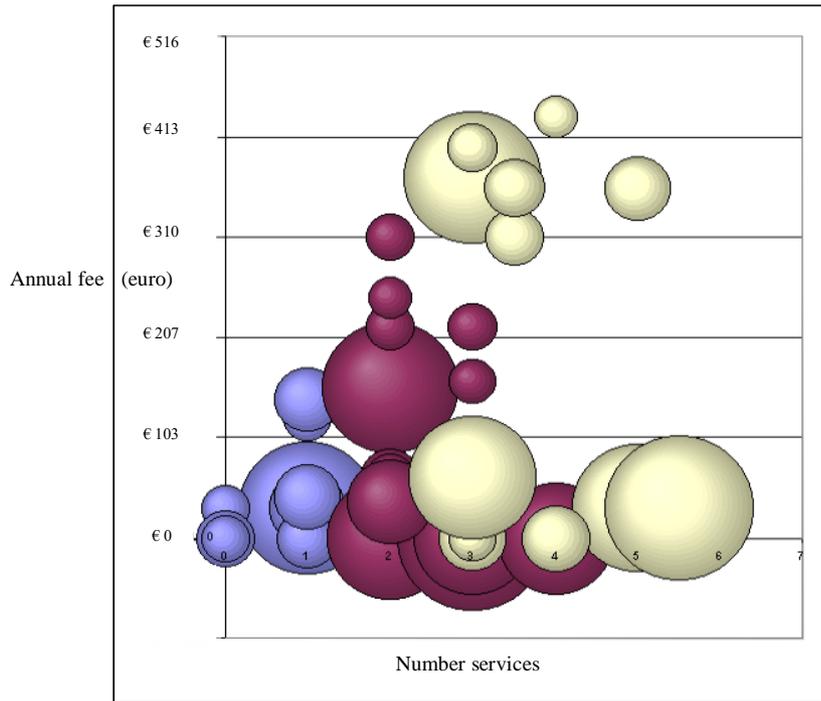


Figure 3. Relationship among the annual fees, services and dimensions of the Banking Institutes for on-line upgrade of existing accounts at June 2002

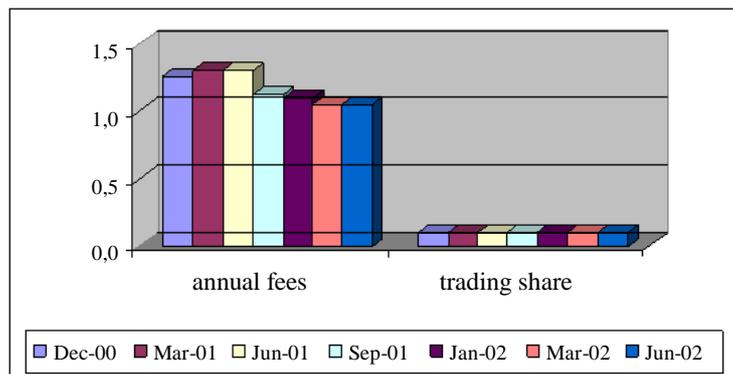


Figure 4. Trend of the variation coefficient of the trading accounts between December 2000 and June 2002

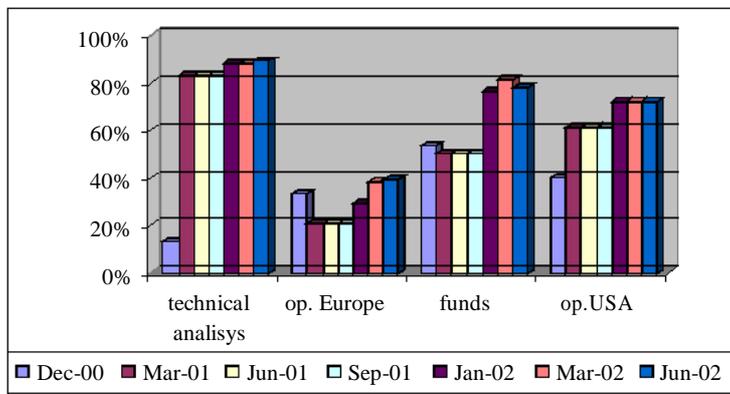


Figure 5. Trend of the services of the trading accounts between December 2000 and June 2002.

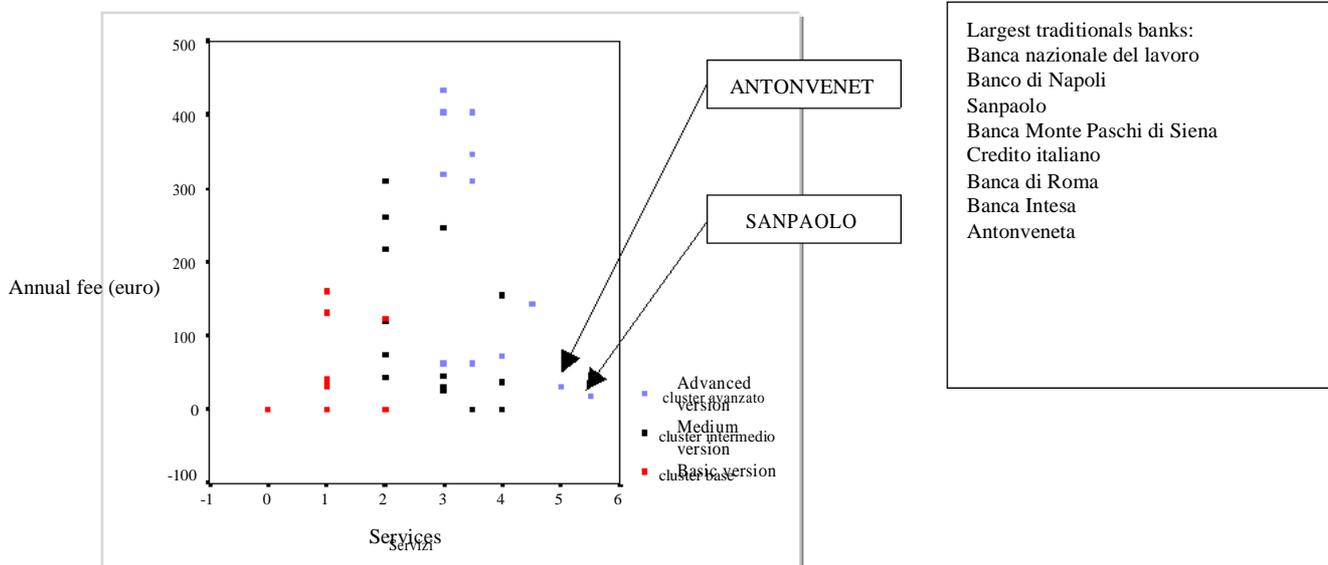


FIGURE 6: relationship among the annual fees, services and of the Banking Institutes for on-line upgrade of existing accounts at June 2002.

## References

- [1] Brynjolfsson E., Kahin B. (2000), "Understanding the digital economy", MIT Press
- [2] Brynjolfsson E., Smith M. (2000), "Frictionless commerce? A comparison of Internet and Conventional Retailers", Management Science (April)
- [3] Saggi di U. Filotto, A. Omarini, U.Pomante (2000), "E-finance e E-commerce", Banksiel

# Simulating the Investor's Behavior in Stock Market with an Intelligent Agent

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## Abstract

In this paper, from the investor's perspective, we will use intelligent agents to simulate the investor's behaviors. The intelligent agent will learn the investor's behavior according to investor's historical data. It will learn from the decisions making for the investment. And we will build a virtual stock market in which intelligent agents can invest according to their decisions. Intelligent agents' investment decisions are different due to different consideration and conclusion for the same message. Then, every intelligent agent will deal with these messages. We will train intelligent agent with data mining technology and artificial neural network to make the intelligent agent's behaviors similar to investor's behaviors in the real world. The intelligent agent makes decisions and invests in the virtual stock market.

## 1. Introduction

The investors will expect satisfactory benefit from the investment by applying best planning. There are many financial management tools about the investment to serve the investors. Some investors may trust the tools and some may doubt of these tools. They may believe in their own judgments or investment consultants. They may have their habits to invest stocks in the stock market. This research is from another point of view to propose a new architecture in which prediction can be performed from investor's perspectives.

An investor is a member in the stock market. Investors make their investment decisions in stock market. Stock price is influenced by their buying or selling stocks, so we can say that investor's supply and demand decide stock price. Because the investor's supply and demand decide the stock price, we can think about stock price from the investor's perspectives.

From the investor perspective of prediction, because investor's supply and demand will form stock price and they decide the TWSP (Taiwan weighted stock price index). The investors sell and buy stocks to decide the stock price. The investor is an entity of the stock market. We can simulate the investor's investment decision or portfolio and put the decision to the virtual stock market. It can decide the trend of the TWSP or the stock price.

So, in this project, we will use intelligent agents to simulate the investor's behaviors. We will use intelligent agents to learn the investors' behaviors according to investor's historical data. Then, agents will find the rules about the investors' behaviors. These rules help agents to

make decisions. And we will construct a virtual stock market that is a virtual place for agent to commit its transactions. If we can learn investor's decision-makings, we can predict the result of weighted stock prices. I hope that the research can provide valuable reference for real investors.

We will discuss background, problem definition and motivation about this research in the following sections.

### 1.1 Background

Some of researches [16,10] use artificial intelligent technologies to predict the tendency of stock market. Others are studies about interest rates [8], and financial data [11, 12]. The others are studies about behaviors [14, 15, 9]. But the price fluctuations of the stocks are the result of individual operations of many individual investors in the financial markets [21]. Most investors believe that messages about stock affect stock prices, and also they have significantly influence on investor's behaviors. Investors invest in the stock market to behave in various manners depending on their individual preference, expectations, decision environment, strategy, and individual difference [6]. So, this paper explores how the investor's behaviors are influenced by the messages about the stock, and also uses investor's historical data to simulate the decision process. We use those approaches to predict investor's behaviors and decisions.

#### 1.1.1 Messages and Information Affecting Investors

The stock price is decided by the supply and demand, and it is also formed by the behaviors of the investors mutually. So, the messages rather affect the stock price than affect the investors. Then, investors' behavior affects the stock price. An investor will anticipate the trend of all investors' trading in the stock market, and the investor may follow the tendency to invest. This tendency is the foundation of stock price [6].

The messages and information that affect the stock market actually affect individual investors or institutional investors. We simulate the investors' decision-makings and predict it according to how investors are influenced by financial messages.

The factors affecting the investors can be classified into following:

- (1) Politics: this includes the war, Cross-Strait relationship and situation of politics. In October of 1998, sent the TAIEX plummeting, where the weighted index had taken a free-fall from its high 10,200 points straight

down to bottom at an all-time low of 5,421 points, this can be the immediate cause of the missile threats by mainland Chinese authorities or the ripple effects of the Asian financial crisis, or a long-time effect of over-specified stock valuations [6]. And some crash situations about politics will also influence the stock market [19].

- (2) Economics: this includes the exchange rate, interest rate, inflation, money supply, international economics, and internal economics. The fluctuation of exchange rate had obvious influence [5]. In the 1997, the Thailand's currency went straight down to 80% in one day. It started the Asia financial crisis. The stock price fell or the foreign money flew out. Those factors triggered the starting time of the financial crisis [3]. The government diminished the interest rate to make increment of money supply. And investors were encouraged to invest their money in the stock market. The international and the internal economics influence investor's behaviors.
- (3) The risk of company: this includes the technical analysis, economic condition, financial structure, cash flow, debt paying ability, buying on margin, short sales, and so on. The market to book ratio has a positive relationship with prior 1,2,3 and 4 period's return rate. Book to market ratio and size effect exists constantly in Taiwan's electronic stocks. This is a positive relationship between return rate and systematic risk [4].
- (4) Others: this includes earthquake and others. The earthquake influences the stock because it will cause much danger for the electronic industry.

### 1.1.2 Investor's Behaviors

Investor's behaviors may change because of the relative messages, technology analysis, base analysis and so on. We can explore the investor's behaviors to analysis his possible investment path. In the common theory proposed by Kenyes, he had done the research about the mentality of the herding people. He pointed out that investors might not make decisions from the information he collected, but investors would follow the herding.

Herding and feedback trade can be used to explain potential finance situations, including excess volatility, momentum and reversals in stock prices.

Herding means that a group of investors follow mutually to trade in the same way in the some period. Feedback trade is a relation between the herding and lag return.

Feedback trade has two types as below.

- (1) Positive feedback trade strategy: The decision threshold is the average performance in the pass. If the stock's performance is higher than the threshold, it can be highly recommended to purchase. If the stock's performance is lower than the threshold, it should be sold.
- (2) Negative feedback trade strategy: It is a negative strategy to the positive feedback trade strategy. Buy the stock if the performance of the stock is lower than the threshold performance, and sell the stock if the

performance of the stock is higher than the standard performance.

The investors follow the same messages to form the herding. The individual investor sells the stock that he earned a few profits, but a loser holds the stock for a long time [18]. The individual investing stocks may follow his own behavior patterns.

The intelligent agent is simulating investor's behaviors in the research. The individual investor may be influenced by messages, individual preferences and wealthy structure. The intelligent agents receive messages about stock to decide buy or sell the stock. These messages include the noise of stock market, the operating situations of companies, and other relative information. The intelligent agent makes different decisions because of the individual preferences. It has also the different influence to stock market because of individual wealthy structure. Every intelligent agent may make different investment decisions. Major Institutional Investors have the huge capital that can be used to buy a lot of stock, and they have strong influence on the stock market. But most of individual investors may have similar tendency about buying or selling, this situation also can make strong influence on the stock market. So, each of investors can play an important role in the market.

## 1.2 Motivation

As discussed above, we can know that an investor is the most important role in the stock market. Because stock price is influenced by investors' buying or selling stocks from economic view according to some researcher's proposition. And then, if we can simulate the investors' behaviors and predict them, we can predict the tendency of Taiwan stock market. So, we will use intelligent agents to simulate the investor's behaviors.

## 1.3 Purpose

Our purpose is to simulate the investor's behaviors with intelligent agent. Intelligent agents will have themselves rules, and we will let the agents to make their decisions according to the rules in the virtual stock market. So we would construct the virtual stock market according to real working operations in the Taiwan stock market. The intelligent agents can buy stock on margin, cash, or short sales in the virtual stock market. Then, we will compare the real trade investors' situations with agents' decisions and evaluate the performance.

## 1.4 Assumption

We use the concept of classification technique of Chinese news proposed by Kun-Po Chuang's thesis, and he had made several assumptions. Therefore, we also have to observe these assumptions as followings.

- (1) We focus on processing Chinese document which contains a caption and a content. (This type of documents includes newspapers, magazines and some reports.)

- (2) Each classification keyword contains at least two characters and the main keywords of a document appear frequently in the document.
- (3) All Chinese news that happens each day can be obtained by every investor.
- (4) Chinese news is affecting the Taiwan Stock Market Weighted Price Index (TSWPI).

And we also have one assumptions in our framework:

- (1) Every investor would obtain all macroeconomic variables and technological analysis variables that happen each day.

The construction in this paper is described as following. In the section two, we will review related literatures and related technologies. Next, we will give a complete description of our model in the section three. In the section four, we will describe the experimental results of our model and analysis the performance of our model. The last is the conclusion and the future works.

## 2. Literature Review

We would introduce technologies that be used in this research.

### 2.1 Artificial Stock Market Technology Review

Shu-Heng Chen and Chia-Hsuan Yeh proposed an architecture to study artificial stock markets. This architecture rests on mechanism called “school” which is a procedure to map the phenotype to the genotype [20]. It’s an agent-based model of “school”, and considers “school” as an evolving population driven by single-population GP [20]. An agent is a trader who is an investor. Traders would learn the investment’s strategies in the business school and trade with these strategies in artificial stock market. This model gives us an ideal about simulating individual investors. In this project, we propose a framework in which we use agents to simulate individual investor’s behaviors. And, we will build the virtual stock market as the ‘school’ in which an agent acts as a trader to make decisions and to invest.

### 2.2 Data Mining Technology Review

Data mining is the process of extracting potentially useful information from raw data [7]. Data mining can mine large amounts of data. This makes data mining a fast and inexpensive way of summarizing, exploring, understanding, and analyzing data [7].

We will find rules from historical data. We will use data mining to find rules. Data mining often mentions finding patterns, rules, and facts in raw data. And we introduce two mining n-dimensional inter-transaction algorithm:

#### 2.2.1 EH-Apriori

EH-Apriori is a method to mine N-dimensional inter-transaction rules. EH-Apriori is the extension of Apriori based algorithm. EH-Apriori adopts a similar technology of hashing to filter out unnecessary candidate

2-itemsets. When the support of candidate  $C_1$  is counted by scanning the database, EH-Apriori accumulates information about candidate 2-itemsets in advance. Such resulting hash table can be used to greatly reduce the number of 2-itemsets in  $C_2$  [10].

#### 2.2.2 OP-Apriori

OP-Apriori is used to reduce the total mining times [5]. OP-Apriori scans the database to find out the  $L_1$  and  $L_2$  in the first time. It doesn’t use  $C_2$  to produce  $L_2$ . It used to need  $C_2$  to produce  $L_2$  before the OP-Apriori method. OP-Apriori modified this way to perform better than EH-Apriori.

Mining n-dimensional inter-transaction association rules is more complex than mining classical association rules. Investor’s behaviors are also complex. We try to use n-dimensional inter-transaction to mine investor’s investment data, and try to find rules about investor’s behaviors.

### 2.3 ANN and Document Classification Used to Deal with News

In the Chunag’s research [13], he combines neural network with document classification techniques to deal with news. Chinese historical news are classified into several fixed categories. And he uses document classification and keywords table to classify these Chinese historical news. He also collects the Taiwan Weighted Stock Price Index (TWSPI) and computes the raising or falling rate every day. And he maps this result to map the Chinese history news. He quantities the information of Chinese historical news by transformation process. Finally, he feeds the quantitative data and qualitative data into artificial neural network and use artificial neural network to train the weights as the degree of influence.

First, he uses these keywords to classify the Chinese history news collected from WWW, as shown in figure 1. After classifying, this component of classification mechanism saves and output some keywords. Secondly, he uses clustering methods to deal with each category. This method would group the similar Chinese history news into the same type for each category. In this framework, he used hierarchical clustering to group the similar news into the same type.

Then, he can use raising or falling rate of each historical news to compute average raising or falling rate for each type. We also compute how many times raising or falling occurs for each type. We use ANN-document classification to deal with news and try to find the news that has influence on investors.

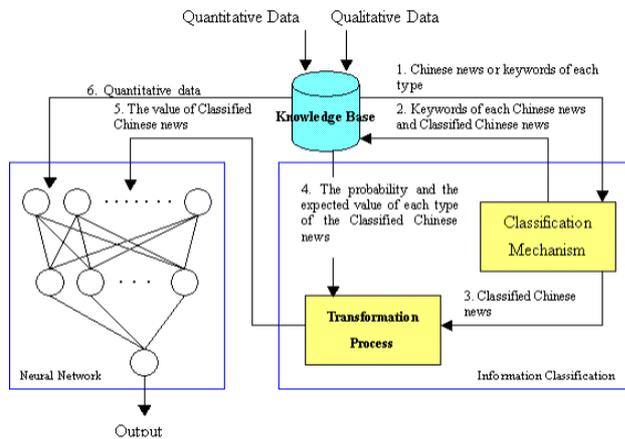


Figure 1. Main Process of ANN and Document Classification Method

### 3. Methodology

We would introduce our methodology in this chapter. We divide this chapter into two parts. The first part is our architecture. The second part is agent's decision framework.

#### 3.1 Architecture

We use agents to simulate real investors' behaviors, and each agent represents an individual investor. Then, each agent has his own decisions and it can make decisions in the virtual stock market. These decisions can affect every stock's price in the virtual stock market. And weighted stock price index is composed of stocks' prices in the virtual stock market, as shown in figure 2.

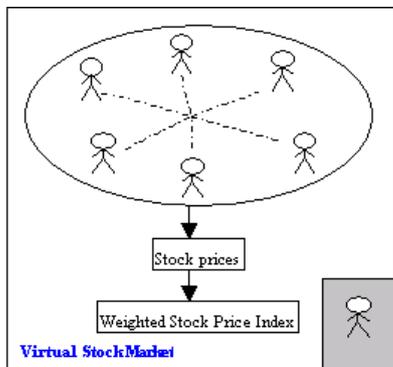


Figure 2. Agent's Decision Making

The agent's simulating architecture would learn from individual investor's historical data. We divide the simulating architecture into two parts. The first part is the agent's learning cycle. The second part is the learning framework for the agent.

##### 3.1.1 Agent's Learning Cycle

Agent's learning model has following elements.

- (1) Historical Data: Investor's investment transactions will be saved to historical data every day. The historical data consists of stock name, stock shares, times, and

other investor's investment information in the past. And historical data also concludes the difference between agent's decision and real investor's decision. Then the difference will be used to modify the agent's learning model.

- (2) Analytic Information: We use historical data to analyze investor's behaviors. The analytic information includes the frequency of investor's trade, individual investors' preference, day interval and rules about investor's behavior.
- (3) Investment Portfolio: This is an investment list that agent may want to invest. Many events influence investor's behaviors. So we will use analytic information and events to find out agent's portfolio.
- (4) Decisions: An agent makes decisions by his portfolio obtained from the step three in virtual stock market.
- (5) Events: Events are the news or qualitative data happening every day. News and messages may affect the investor's behaviors. So we will use ANN-Document Classification to deal with the events.

The agent's learning cycle is shown in figure 3. First, this model will save the investor's historical investment data and use historical data to analyze investor's behaviors. But events also may affect investor's behaviors. So, we use analytic information and events to decide agent's portfolio.

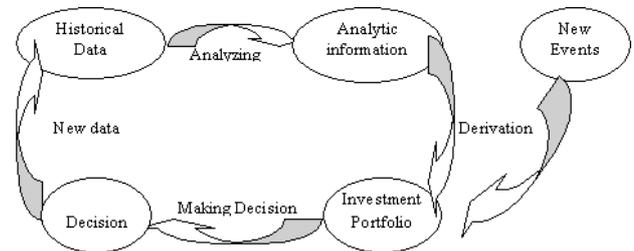


Figure 3. Intelligent Agent's Decision Learning Cycle

Then, agents can make their decisions in the virtual stock market by his portfolio. Finally, there may be difference between the agent's decisions and the real investor's decision. The difference and the real investor's decision become the new data for next learning cycle. Then, the agent will learn the historical data and the new data in the next learning cycle.

##### 3.1.2 Learning Framework for an Agent

The research would construct the framework to simulate the investors. The framework consists of the following components shown in the figure 4.

- (1) Individual Wealth Structure: Individual wealth structure means how much money an investor can invest in the stock market. Individual investor has himself individual wealth structure. Individual wealth structure would record the wealthy distribution about bonds, common fund, stocks and so on. In the record, we can find how much money investor can invest in the stock market. If an agent

has ability to buy more stocks, he has more influence to the stock market. An agent's wealthy structure would change while an agent gains or loses from investments, and he will leave from the virtual stock market if he loses all of his money. An agent also can enter the market again if he has money. Wealthy structure decides whether an agent is active or not in the virtual stock market.

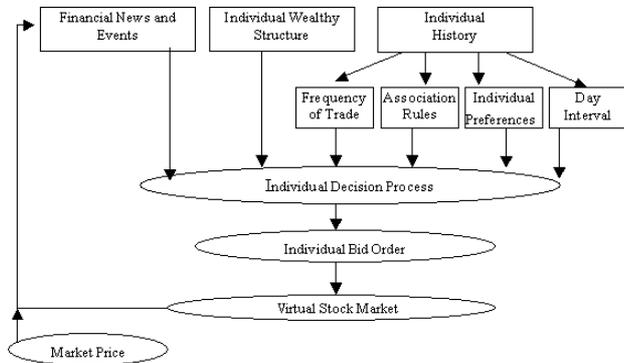


Figure 4. The Framework of Simulation

- (2) Individual Investor Historical Data: This component stores data that investors invest every day. The data of this component includes: 1. stock names, stock prices, and stock shares that investors buy or sell. 2. information about investor's buying stocks on margin sales or short sales.
- (3) Individual Decision Process: Individual decision process uses the frequency of trade, individual preference, association rules, and day interval form the component two. And individual decision process will produce individual bid order of an agent.
- (4) Individual Bid Order: Individual bid order is the trading list that an agent will trade next week. The intelligent agent will make decisions by his bid order next trading week in the virtual stock market.
- (5) Virtual Stock Market: We will construct the virtual stock market to simulate the real stock market in Taiwan. The virtual stock market includes three parts.
  - (a) An Intelligent Agent: An intelligent agent represents an investor. An agent can trade according to his bid order in the virtual stock market.
  - (b) Model of Price Determination: The mechanism is to decide the stock price at which agents buy or sell. And the mechanism is similar to the real Taiwan stock market. The agents can buy the stocks by cash, margin sales, and short sales. Virtual stock market may decide the stock price according to the agents' investment decisions, buying or selling the stock.
  - (c) Taiwan Weighted Stock Price Index (TWSP):

The virtual stock can decide the TWSP according to all stocks' prices. So we can find that the supply and demand from the intelligent agents in the virtual stock market can predict the Taiwan weighted stock price index.

### 3.2 Agent's Decision Framework

This part will introduce the technologies used in the agent's decision framework and we will explain how to construct our framework step by step. Our framework is shown in the figure 5 and it has several elements as followings:

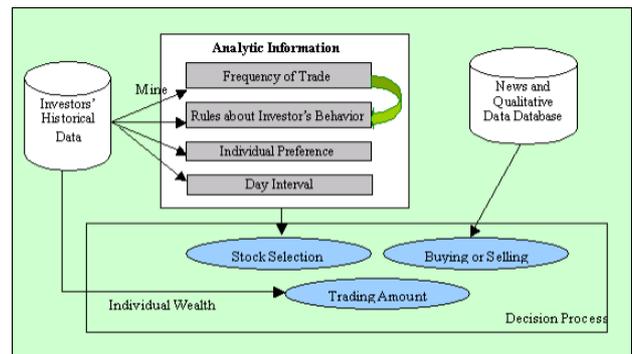


Figure 5. Agent's Decision Framework

- (1) Buying or Selling Stocks: We will collect all kinds of events including news or qualitative data, and use the events to decide whether investor would buy or sell stocks or not. We will also construct database to save news and qualitative data, and use ANN-document classification methods to deal with news and qualitative data. Then, we can obtain the result and use the result to decide whether investor would buy or sell stocks or not.
- (2) Trading Amount: Trading amount means how much money an individual investor can invest in stock market. We can compute investor's wealth from the transactions of investor's investment in the stock market and infer individual investor's trading amount that may investe in the stock.
- (3) Stocks Selection: We will use analytic information to select stocks that an individual investor may invest in the stock market. We can find analytic information from investor's historical data. Analytic information includes rules about investor's behaviors, individual preferences, and frequency of trades. We use n-dimensional inter-transaction (OP-Apriori) and Apriori to mine associate rules. The frequency of trades will be used as scale of sliding windows' dimensions. If an investor has higher investment frequency in the same stock, we can get the higher value of individual preference. Then the higher value of individual preference means that the investor has better opportunity to invest in the stock. Day interval is the duration of two successive transactions for the same stock committed by an investor. So we can use the analytic information to select stocks that investor may

invest next week.

### 3.2.1 Buying or Selling Stocks

We can use events to decide whether investor would buy or sell stocks or not. The events include news, technology analysis data, economic variable, and EPS etc. We will use ANN-document classification to deal with events that may influence investor's decisions. Every investor has different decision about the same events. We use ANN-document classification to deal with events and try to find degree of influence for each agent. Every agent has his own ANN-document classification to deal with news that may influence the investor and trains his ANN-document classification according to his buying or selling stocks every day. We describe the process in the followings.

(1) Inputs: ANN's input includes following elements. And following element would be save in news and qualitative data database in figure 5.

- (a) Qualitative Data: this part is responsible to search daily Chinese news, including internal politics, political situations, internal economic situations, international political situations, international economic situations, company situations, cross-Strait relationships, general investment environments, and so on.
- (b) Macroeconomic Variables: this part is responsible to search several economic indicators consisting of daily change in exchange rate, daily change in interest rate, monthly change in unemployment rate, annual change in economic growth rate, annual change in consumer price index, annual change in Gross Domestic Product (GDP), monthly change in inflation rate, and monthly change in money supply rate. These data can be collected from several major countries, including American, Japan, Hong Kong, Singapore, Korea, England, France, and Germany.
- (c) Technological Analysis Variables: this part is responsible to search Taiwan Weighted Stock Price Index (TWSPI) and compute several technological indicators, including Twenty-Four Days Moving Average (MV), Relative Strength Index (RSI), Bias, Moving Average Convergence/Divergence (MACD), Volume Moving Average, and Twenty-Four Days On Balance Volume (OBV).

(2) Outputs: Individual investors may buy or sell their stocks. Events influenced whether the investors would buy or sell stock or not. We assign one to buying stock and assign -1 to selling stock.to train the ANN-document classification model.

(3) Prediction: We will predict whether the investors would buy or sell stock or not next week.

### 3.2.2 Trading Amount

We may not have individual wealthy structure. But we can compute individual wealthy through an investor investment in stock market. We will find how much money an investor can invest in the stock market. This can influence how many stocks that an investor can invest. We will use following equation to compute trade size, as shown in figure 6

An investor may own following stocks, and we can compute his wealthy.

Asset	Shares	Prices
Stock <sub>1</sub>	Share <sub>1</sub>	P <sub>1</sub>
Stock <sub>n</sub>	Share <sub>n</sub>	P <sub>n</sub>

$$\text{Trading Amount} = \text{Share}_1 * P_1 + \dots + \text{Share}_n * P_n$$

Figure 6. Trading Amount

### 3.2.3 Stocks Selection

Analytic information includes frequency of trade, rules about an investor's behaviors, individual preferences, and day interval as shown in figure 5. We use analytic information to select stocks.

#### (1) Frequency of Trade

This part will compute the frequency of trade that an investor may trade daily, weekly, monthly, or a long time from his historical data. An investor has his own habits to trade stocks. We will use following equation to compute average frequency of trade, as shown in figure 7. We can use frequency of trade to be the size of each dimension for the sliding window.

T<sub>1</sub> : Trade date that an investor invest the first time

T<sub>2</sub> : Trade date that an investor invests the next time

T<sub>n</sub> : Trade date that an investor invests Nth time

$$\text{Frequency of Trade} = \frac{\langle T_2 - T_1 \rangle + \langle T_3 - T_2 \rangle + \dots + \langle T_n - T_{n-1} \rangle}{N-1}$$

One scale of Sliding Window's "Time" Dimension = Frequency of Trade

Figure 7. Frequency of Trade

#### (2) Mining Rules about Investor's Behaviors

We use OP-Apriori and Apriori algorithm to find out rules about investor's behaviors from individual historical data. When algorithm scans the database, it will produce C<sub>1</sub> and C<sub>2</sub> directly the first time. And we will record the support of C<sub>1</sub> and C<sub>2</sub> in an array after scanning the database. We will mine association rules for investors' behaviors with following steps.

- (a) Transforming to Star Schema: We will transform our individual historical data into star schema and we will transform all

transactions to star schema in the next step. Table 1 shows the original data and the table 3 shows its star schema. And table 1 shows the meaning of the sliding window's dimension.

Table1 Original Data in Database

Investor	Stock-Number	Buy-or-Sell	Price-Difference	Time
A	2806	sell	2	4/22
A	2409	sell	3	4/23
A	2409	buy	-2	4/24
A	2325	buy	-3	4/25
A	2806	buy	-1	4/26

Dimension one: dimension one is the field of buying-or-selling and its value can be sell or buy. Then we transform "buy" to "1" and "sell" to "2".

Dimension two: dimension two is the field of price-difference and its value can be -3, -2, -1, 2, or 3. Then we transform "-3" to "1", "-2" to "2", "-1" to "3", "2" to "4" and "3" to "5".

Dimension three: dimension three is the field of time and its value can be 4/22, 4/23, 4/24, 4/25, or 4/26.

$$\text{Frequency of trade} = \frac{(4/23 - 4/22) + (4/24 - 4/23) + (4/25 - 4/24) + (4/26 - 4/25)}{5 - 1} = 1$$

The scale of dimension three is one.

Then we transform "4/22" to "1", "4/23" to "2", "4/24" to "3", "4/25" to "4" and "4/26" to "5".

Table 2. Meaning of Sliding Window's Dimension

		Value	Meaning of Value
Events		a, b, c	a is {2806}, b is {2409}, c is {2325},
Dimension One	Buy-or-Sell	1, 2	1 is {buy}, 2 is {sell}
Dimension Two	Price-Difference	1,2,3,4,5,6	1 is {-3}, 2 is {-2}, 3 is {-1}, 4 is {2}, 5 is {3}
Dimension Three	Time	1, 2, 3, 4, 5	1 is {4/22}, 2 is {4/23}, 3 is {4/24}, 4 is {4/25}, 5 is {4/26}

Table 3. Comparison of Sliding Window's Dimension

Investor	Stock Number	Event	Buy or Sell	Dimension One	Price Difference	Dimension Two	Time	Dimension Three
A	2806	a	Sell	2	2	4	4/22	1
A	2409	b	Sell	2	3	5	4/23	2
A	2409	b	Buy	1	-2	2	4/24	3
A	2325	c	Buy	1	-3	1	4/25	4
A	2806	a	Buy	1	-1	3	4/26	5

(b) Scanning the Database: OP-Apriori will scan the investor's star schema. There are two steps as followings. First, it scans each point in the N-dimensional database with sliding windows to find base address. Secondly, it will infer the relative address according to base address and it will move the sliding window to scan the n-dimension database.

By using the data in table 3, we can draw a 2-dimensional sliding window as shown in figure 8.

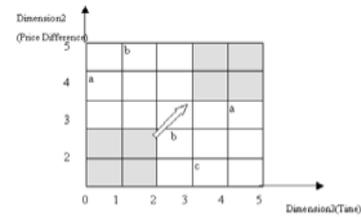


Figure 3-8: A Sliding Window Example

Figure 8. A Sliding Window Example

(c) Saving the Association Rules: We will record these association rules, and an agent will use these rules to select stocks.

(d) Saving the Association Rules: We will record these association rules, and an agent will use these rules to select stocks.

### (3) Individual Preferences

An investor may interest in some kind of stocks. If someone likes to invest in stocks of electronics industry, he may be familiar with Taiwan Semiconductor Manufacturing Company and United Microelectronic Corporation. If he invests in Taiwan Semiconductor Manufacturing Company and United Microelectronic Corporation, he may interest in investing in other stocks of electronics industry. An investor may interest in several kinds of stock. So, we can find the stocks that he prefers to invest.

### (4) Day Interval and Density Rate

Day interval is N's trading date minus N-1's trading date of the same stock for the same investor. Density rate is how many times that an investor invests in the same stock the same week.

There is an example in the following table 4. First, we would compute the day interval that investors invest in the same stock. Investor A invests in stock A on 2001/3/18, 2001/3/19, 2001/3/26 and 2001/3/28. We can compute the day interval which are 0, (2001/3/19 - 2001/3/18), (2001/26 - 2001/3/19), and (2001/3/28 - 2001/3/26). And we can get the day interval, 0, 1, 7, and 2. The one represents that investor A may trade stock A next day. The two represents that he may trade stock A next two days. We use following rules to compute density rate as shown in figure 9.

Table 4. Investor's Data

Auto_Number	Investor's Name	Stock Name	Date
1	Investor A	Stock A	2001/3/18
2	Investor A	Stock A	2001/3/19
3	Investor A	Stock A	2001/3/26
4	Investor A	Stock A	2001/3/28

---

```

Day Interval= Daten - Daten-1
If 0 < Day Interval < 7 then
  Count=Count + 1
endif

Density Rate= Count /Sum of Trading Times

```

---

Figure 9. Day Interval

We will compute the sum of trading times of the investor A. Because we have four data for investor A, its sum of trading times is four. There are two data with day interval between 0 and 7. So, the density rate is fifty percent, two of four.

Fifty percent is high rate of density and it has high correlation this week. But it may not have any correlation between two weeks. If the density rate is higher than fifty percent, it has higher correlation on one week. And we can use the stocks transacted in the preceding half of the week to predict the stocks that investors will trade in the next half of the week.

#### (5) Main Algorithm to Select Stocks

We have following steps to select stocks according to the result obtained from previous steps:

Step 1: Searching the association rule database

In this step, we will use the following algorithm to search the association rule as shown in figure 10.

---

```

IF support value > threshold, then
  association rules will be selected
  IF the number of appropriate stocks > 2, then
    compare the stock of association rules, and find the popular stock
    then output the stock name
  else output the stock name
else
  Search the preference database and day interval database.

```

---

Figure 10. Selecting Rules

Step 2: Searching preference database and day interval database

We use ANN-document classification to decide whether an investor would buy or sell stocks or not. If we know an investor who will buy the stock next week, we find the preference of his buying stock in the past. And we select the most popular stocks in the buying preference data. If we know an investor who will sell the stock, we find the preference of his selling stock in the past. We also would use the final n trading data to find day interval of these

stocks. Finally, we select the most popular stock in the selling preference data and select the most popular stocks in the day interval database.

### 3.2.4 Individual Decision Process

Agents will use analytic information to select stocks which an individual investor may invest in the stock market. An agent will select the stock that an agent will invest according to the step of stocks selection. An agent computes the average trading amount of each trading, and he gets the stock quantity that an agent will invest in the virtual stock market. An agent uses ANN-document classification to decide whether an investor would buy or sell stocks or not. And the agent will take the action, buy or sell. Therefore, an agent issues a bid order showing his investment data. An agent will use his bid order to trade in the virtual stock market.

## 4. Experiment

In this section, we will introduce data preparation, experimental design, and experimental results.

### 4.1 Data Preparation

We would simulate an investor's behaviors, and we need to collect individual investors' investment data. But, it is not easy to obtain individual investor's investment data due to personal privacy. There is an opportunity to get simulated data. In a class, the instructor teaches students how to operate stock's relative softwares and let students simulate investing in stocks. These students work for semiconductor manufactures located at the Hsinchu Science-Base Industrial Park and they are familiar with stock market. They usually trade in the stock market. The instructor assists us to achieve students' investment data. So, we use these data as our experimental data.

### 4.2 Experimental Design

We will perform the experiment in the three sections. In first section, we use an investor's preference stocks to predict stocks' name that an investor will trade next week for each agent. In second section, we combine the individual preference stocks and the day interval to predict stocks' name that an investor will trade next week for each agent. In third section, we use individual preference stocks, the day interval, and association rules to predict stocks' name that an investor will trade next week for each agent. The result of first section and second section will be compared with the result of third section.

### 4.3 Experimental Result

We trained our agents with the simulated data. The result of experiment is shown in table 5. Prediction of 54.3 percent of investors is better than other predictions. Prediction of 14.3 percents of investors is not better than other prediction. Prediction of 11 percents of investors is

the same percentages as other predictions. There is a better result than other predictions in the whole.

We would integrate the result in the table 6. We have prediction rate of 37.3 percent in total average. There are some investors that almost never trade in the same stocks and we cannot predict their behaviors. If we drop these investors, we can get the prediction of 42.19 percent. It would have 40 percent of investors that has high prediction rate, 58.57%, and standard deviation is 0.0875. So, the accuracy rate of each investor is approximate. Therefore, our result has high representation. This is the best result for the experiments. There would be 11.4 percent investors of investors that we cannot predict and their prediction rate is zero. It is not the best prediction, but it also can be accepted.

Table 5. Integrated Prediction of Experiment

Investor	Preference Average	Day Interval Average	Density Average	Average in proposed Model
A001	20%	20%	20%	25%
A002	60%	80%	80%	60%
A005	35%	47.5%	47.5%	50%
A009	60%	60%	60%	60%
A011	20%	20%	20%	30%
A015	22.5%	22.5%	22.5%	20%
A017	50%	50%	50%	50%
A027	0	0	50%	50%
A035	45%	70%	70%	65%
A039	25%	22.5%	22.5%	25%
A043	42.5%	70%	70%	80%
A049	20%	20%	20%	25%
A051	31.4%	38.5%	38.5%	40%
A053	0	35%	35%	35%
A057	0	0	0	0
A061	45%	45%	45%	50%
A063	20%	10%	10%	20%
A069	0	0	20%	20%
A071	35%	35%	35%	40%
A073	20%	20%	20%	20%
A077	60%	60%	60%	65%
A081	12.5%	12.5%	12.5%	15%
A085	65%	65%	65%	65%
A093	0	10%	0	0
A095	32.5%	32.5%	32.5%	35%
A099	10%	32.5%	32.5%	33%
A101	0	0	0	0
A105	65%	65%	65%	40%
A109	40%	60%	60%	65%
A113	60%	60%	60%	60%
A115	25%	50%	50%	45%
A121	34.3%	48.6%	48.6%	50%
A123	12.5%	25%	25%	20%
A129	60%	40%	40%	50%
A131	0	0	0	0
Average	29.4%	35.1%	36.7%	37.3%

Table 6. Total Average Prediction Rate

	Percentage Data	Average Prediction	Standard Deviation	Notation
Prediction Rate between 50%-100%	40%	58.57%	0.0875	Good
Prediction Rate between 30%-50%	22.9%	37.25%	0.0452	
Prediction between 1-30%	25.7%	20.63%	0.02997	
Prediction Rate = 0	11.4%	0	0	Bad
Total average		37.3%		
Net Total Average*		42.19%		

\* Net Total Average excludes the records with prediction rates = 0.

## 5. Conclusion

In this research, an agent would simulate an investor's behaviors according to his historical data. An agent can find the analytic information including association rules, preference stocks of an investor, and so on. The agent would use the analytic information to predict the stock that agent would trade next week. In experiment, we would have a satisfactory prediction rate.

This research would provide another perspective for investors to think how to predict the trend of stock. The stock price is decided by the supply and demand. Every investor plays an important role in the stock market. If we can predict the investors' behavior more accurately, we can predict the trend of weight stock price in Taiwan stock market better.

The following work can be continued in the future: The following work can be continued in the future:

- (1) Classifying the Investors according to Investors' Intentions: Because there are so many investors in stock market, we can't simulate every investor. So we can classify the investors according to investors' intention. For example, some of investors will invest the other financial market including bonds, mutual funds and treasury bills etc for avoiding risk. Another investors will accept high risk because high-risk assets may offer higher expected returns than low-risk assets may offer. The others may not care risk of stocks at all, and they have their investment principles like herding, positive feedback trade strategy, negative feedback trade strategy and etc. So, we can classify investors to several classifications in the future work.
- (2) Getting Real Investors' Investment Data: Our data is simulated data, not real investors' investment data. There may be differences between simulated data and real investors' investment data. If we can collect the real investors' investment data, we can predict better. The followings can be considered in the future.
  - (a) Hundreds or Thousands of Investor's Data: If we can get these data, the model will perform better. If we can get hundreds of investors' data or thousands of investors' data, use our agents to simulate. It can produce plenty of trading data in the virtual stock market and agents can trade with the other agents. This architecture can

perform better than results that have done in our experiments.

(b) Long Data Period: Experimental data should be collected for a period longer than six months, a year or a cycle period to train our agents. Enough data can train our agent that can be similar to real investors.

(3) Getting Data from Three Major Institutional Investors (TMII): Major Institutional Investors have the huge capital that can be used to buy plenty of stock, and they have strong influence on the stock market. So, we can collect the investment data of TMII and use our agents to simulate the behaviors of TMII. We can modify our agents' architecture to fit with the behaviors of TMII. It can be a right direction for the future works.

## References

- [1] 李治平, 2000, 「亞洲金融風暴與國外機構投資人之行為與影響」, 國立台大財務金融研究所碩士論文。
- [2] 林介勝, 2000, 「影響台灣電子股報酬之共通因素研究—以LISREL探討各影響因素間的可能關係」, 國立台大財務金融研究所碩士論文。
- [3] 周欣倫, 2000, 「台灣股票市場外匯暴露性之探討」, 國立東華大學國際經濟研究所碩士論文。
- [4] 馬武三, 2001, 「台灣上市公司各產業之類股報酬型態分析—亞洲金融風暴期間之驗證」, 國立交通大學經營管理研究所碩士論文。
- [5] 許長裕, 2001, 「多維度跨界性資料挖掘—以股市為例」, 國立中央大學資訊管理研究所碩士論文。
- [6] 謝榮記, 2000, 「台中地區個別投資人對訊息心理反應與加權股價指數關聯性之研究」, 私立朝陽科技大學財務金融研究所碩士論文。
- [7] Ashraf Azmy(1998), "SuperQuery; Data Mining for Everyone", [Http://www.azmy.com](http://www.azmy.com)
- [8] B. Bouqata; A. Bensaid; R. Palliam, (1999), "Recurrent Artificial Neural Networks for Forecasting of Forward Interest Rates", Neural Networks, 1999, IJCNN 1999, International Joint Conference on Volume: 6, Pages: 3894–3897.
- [9] F.M. Werner; Bondt De (1998), "A Portrait of the Individual Investor", European Economic Review 42, Pages: 831-844.
- [10] H. Lu; J. Han; L. Feng (1998), "Stock Movement Prediction and N-Dimensional Inter-Transaction Association Rules." In Proceeding ACM SIGMOD Workshop on Research Issues on Data Mining and Knowledge Discovery, Pages: 12:1-12:7, Seattle, Washington, June 1998.
- [11] H. Iba; T. Sasaki, (1999), "Using Genetic Programming to Predict Financial Data", Evolutionary Computation, CEC 1999, Proceedings of the 1999 Congress, Pages: 245-251.
- [12] J. Roman; A. Jameel, (1996), "Backpropagation and Recurrent Neural Networks in Financial Analysis of Multiple Stock Market Returns.", System Sciences, 1996, Proceedings of the Twenty-Ninth Hawaii International Conference on Volume: 2, Pages: 454–460.
- [13] Kun-Po Chuang; Deng-Yiv Chiu (2001), "Predicting the Tendency of Stock Market in Taiwan Using Neural Network and Document Classification Technique", Chinese Institute of Industrial Engineers 2001, A16-1.
- [14] Lee, Charles M.C.; Radhakrishna, Balkrishna (2000), "Inferring Investor Behavior: Evidence from TORQ Data", Journal of Financial Markets, Volume: 3, Issue: 2, Pages: 83-111.
- [15] M. E. Malliaris, (1994), "Modeling The Behavior of the S&P 500 Index: A Neural Network Approach", Artificial Intelligence for Applications, 1994, Proceedings of the Tenth Conference, Pages: 86–90.
- [16] N. Baba; N. Inoue; H. Asakawa, (2000), "Utilization of Neural Networks and Gas for Nonstructuring Reliable Decision Support Systems to Deal with Stocks.", Neural Networks, 2000, IJCNN, Proceedings of the IEEE-INNS-ENNS International Joint Conference on Volume: 5, Pages: 111–116.
- [17] Odean; Terrance (1998), "Are Investors Reluctant to Realize Their Loses?", Journal of Finance 53, Pages: 1775-1798.
- [18] Rast, M. Fuzzy (1999), "Forecasting with Fuzzy Neural Networks: A Case Study in Stock Market Crash Situations", Information Processing Society, 1999. NAFIPS. 18th International Conference of the North American, Pages: 418–420.
- [19] Rakesh Agrawal; Ramakrishnan Srikant (1994), "Fast Algorithms for Mining Association Rules," In Proceeding 20th Int. Conf. Very Large Data Bases, VLDB, Pages: 478-499.
- [20] Shu-Heng Chen; Chia-Hsuan Yeh (1999), "Genetic Programming in the Agent-based Artificial Stock Market", Evolutionary Computation, 1999. CEC 99. Proceedings of the 1999 Congress on Volume: 2, Pages: 834-841.
- [21] Sorin Solomom (1999), "Behaviorly Realistic Simulations of Stock Market Traders with a Soul", Computer Physics Communications, Pages: 161-167.

# Mobile Business: Characteristics, Advantages and Strategies

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## Abstract

The introduction of Internet technology has led to the business revolution, the so-called e-business. As a consequence, the e-business led the surprising economy booming for certain years. However, in the last few years, e-business also led to a global economy recession. The rises and falls of e-business raise curiosity to researchers for further investigation on the impacts of Internet technology on the business operations. What goes wrong with e-business becomes an interesting question, and deserves in-depth investigation.

In this paper, we give the definition of mobile business and construct its advantages. We analyze why e-business did not perform well in the last few years by showing how traditional Internet users were blocked by corporate firewalls from interactions with e-business.

Based upon transaction cost theory, we decompose transaction cost into analytical components: transportation cost, information cost, telecommunications cost and management cost, and therefore, derive the profit realization equation. We then use this profit realization equation to analyze how mobile technology impacts business operations.

As a result, this paper provides an analytical framework for enterprises implement mobile business and reengineer business operations. The enterprises can therefore set up corporate strategy to restructure the enterprise resources to build superior core competence and enhance corporate competitive advantages.

## 1. The Rises and Falls of Internet Economy

The introduction of Internet technology has led to a brand new way that business communicates. As a consequence, business operations changed accordingly, and led to the new way of business operations and strategies, namely, e-commerce, and furthermore, e-business.

The evolution of Internet and e-business has not only greatly innovated the way we operate business, but also dramatically revised the way we evaluate the stock values in global market. Due to the revolutionary value changes, the Internet technology and e-business has gained global attentions, and has been studied by researchers on how they impact the existing and future businesses.

Recently, after the global economy recession and the so-called DOTCOM bubble, the e-business has been

severely reviewed. Since then, people are trying to find out what goes wrong with Internet and e-business. Nevertheless, e-business has always been a critical factor reshaping the way business operates.

## 2. The Synergy of Mobile and Internet Technology

Due to the Internet revolution, each business can globally reach all the supply resources and global market demands with fingertips. Enterprises began to compete in global bases, and therefore, intensified global competitions. As a consequence, enterprises must find more efficient ways for business operations.

The usages of mobile phones (Stallings, 2001; Fitzgerald and Dennis, 2002) freed enterprises from having employees working in offices and waiting for clients to call in. Therefore, enterprise may send employees out to meet the potential suppliers and to really on site qualify the services or product quality; and to take care of the customers face-to-face for better customer satisfactions. Even if face-to-face is not possible, the mobile phones give employees mobility to move from one place to another to concurrently schedule, handle and process simultaneous business events.

While the employees are away from office, how about the support information for business execution and decision-making? Calling back to the office for information could do it, of course. However, the enterprise can do better by retrieving information and work instructions over Internet via mobile devices. In other words, mobile employees do not need to travel back and forth between offices and the meeting locations, and hence dramatically save traveling times, and reduce the setup times between activities. The number of accomplished activities, such as sales, purchases or customer cares, can be greatly increased. Therefore, the synergy of mobile and Internet technology innovates a new form of business operation — the mobile business.

## 3. The Characteristics and Advantages of Mobile Business

To better describe mobile business, we call the old style e-business the traditional e-business, or fixed-business. In fixed-business, enterprises started to

build web sites that store business related information and business operation processes. These web-based information and business processes are the keys to the evolution of e-commerce.

Given the technology advances (Stallings, 2001; Fitzgerald and Dennis, 2002), Internet mobile phone is available in the market. With the integration of Internet and mobile phone into business operations, for example, I-mod (Takeshi, 2000), the mobile business is created. Mobile business is then an extension over fixed-business with mobile Internet communications technology. In other words, the fundamental differences between mobile business and fixed-business are the mobility and always-online capabilities. (For convenience, we use mobile phone to mean Internet mobile phone for the rest of this article.)

To be specific, we define mobile business as follows:

Mobile Business: a business that utilizes the mobile and Internet technologies, and empowers the employees with mobility and always online to access business intelligence and mission processes.

Therefore, the mobile business enterprise must be on Internet, and has a databases to store business intelligence and mission processes. Also, the employees are mobile, and maybe the offices are mobile, too. The employees are free to travel without losing the connectivity with the enterprise. In other words, mobile business can be characterized by the following three characteristics:

- (1) Mobility: Mobile employees, and the offices too, are the trend of contemporary enterprises.
- (2) Always Online: employees, offices and enterprise body are always online, connected together, and ready to communicate with each other.
- (3) Online Business Intelligence and Process: The business intelligence and processes are electronically stored in the business system, and can be retrieved via Internet by mobile phones.

The mobility characteristic of mobile business comes with the innovation of global mobile phone systems. It is known that mobile phones are lightweight and small enough to be carried around anywhere at anytime (May, 2001). It is also known that the mobile phones are much easier to use than PCs, and could be described as a device for anybody. The always online and Internet enhancement allow the owner to retrieve information and business processes over Internet. Therefore, the add-on of mobile phones gives the following advantages to business operations.

- (1) Anybody: The mobile phone is easy to use for anybody, not just young kids but also easy to use for old ones or even busy business executives;
- (2) Anytime: The mobile phone is always accompanying with the owner at anytime;
- (3) Anywhere: The mobile phone is always accompanying with the owner in anywhere;
- (4) Any information: With business Internet enhancement, the mobile phone is able to communicate with Internet devices, client PC,

server and others, through certain format or protocol translation, to retrieve any information;

- (5) Any process: With built-in enterprises' mission processes on line, mobile phone can assist employees to follow the procedure to accomplish given mission;
- (6) Mission-trigger operation: to be described in the following section.

#### 4. Mission Sequence and Mission-Trigger Operation

A mission is an attempt to accomplish a goal. And each mission can be successfully accomplished if each of the following steps is realized:

- (1) Right person carries out this mission,
- (2) At right time,
- (3) In the right place,
- (4) With sufficient information on hand, and
- (5) With process assistance for decision-making or taking actions to execute the mission process.

For convenience, we call the above Mission Sequence.

An execution of business mission (or activity, task, assignment...) is called mission-trigger if the mission can be automatically triggered to execute by an associated mission sequence. A mission-trigger operation can be stated as an automated execution of mission operation, and can be depicted by the following figure:

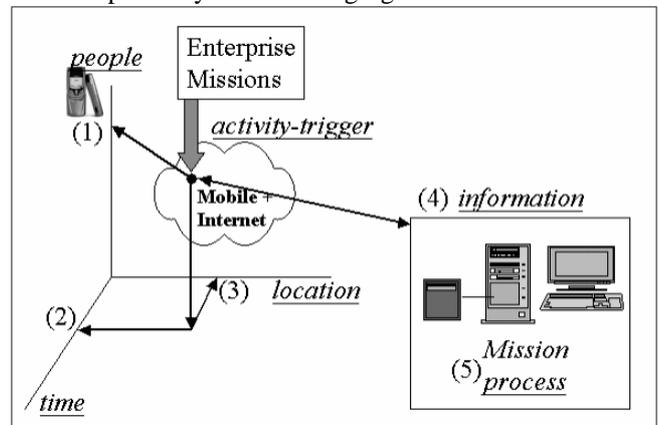


Figure 1: The Mission Sequence and mission-trigger operation

With mobile business technology, the business operation systems can automatically help (1) identify available qualified responsible persons (2) at anytime (3) in anywhere, and can trigger the designated persons to (4) retrieve sufficient information, and (5) furthermore assist the person with predefined mission process to accomplish the mission. We therefore claim that mobile business can be of mission-trigger characteristics.

There are lots of examples for mission trigger operations in the mobile business environment. For example, in parcel pickup and delivery service industry, we may have each service truck equipped with a GPS

system and mobile connection device. Then, once receiving a service request to pick and deliver a package, the dispatching center can identify the most appropriate vehicle near by the pickup location at that time, pass to it customer service information, and assist to perform the service with predefined procedures.

Corporate with better competitiveness, of course, may have better capability to realize the mission. Let  $r$  be the possibility of accomplishing a given business mission. Furthermore, let  $r_b, r_t, r_w, r_i, r_e$  be the probability of the right person, right timing, right place, right information and right procedure assistance to execute the mission, respectively. Then, we have the following competitive factor equation:

$$r = r_b r_t r_w r_i r_e$$

It is worthwhile to point out that if the possibility of each of the 5 factors is increased by a factor of 2, then the total possibility is improved by a factor of  $2^5=32$ , which is a significant improvement to corporate profit generation.

The advantages of mobile business imply that each of  $r_b, r_t, r_w, r_i, r_e$  may approach to 1 and hence increase the possibility of successfully accomplishment of business missions. The mission trigger operation can be effectively implemented especially if mobile technology is deployed, and is very important for contemporary enterprises competing in the intensifying competitive global market. The mission-trigger operation is an automated execution of business mission, and therefore is an ultimate advantage of mobile business that is never available before.

## 5. What Goes Wrong with Traditional e-Business?

For a long time, the introduction of Internet really empowered the business and the employees. It is expected that e-business is a friction-free economy. That is, with very little marginal cost, there will be immense volume of products or services out there in Internet market waiting for consumers to acquire, or for providers to supply. Therefore, industrial analysts believed that the e-business will revolute the business operations and dramatically promote business productivity. Therefore, e-business led to a booming global economy.

However, investors gradually realized that the promising DOTCOM enterprises do not overturn the traditional business. The e-business does not have enough momentum to generate profit, and finally, led to a global economy slum. Why does not the immense friction-free equilibrium quantity get realized in practice? To answer what the traditional e-business goes wrong, our analysis of mobile business advantages provides fundamental insights.

Traditional e-business has PC (or notebook PC) as the only Internet connection device. First of all, PC is complicated to use to most users, and therefore, not suitable for everybody. PC is not convenient to carry while traveling. So, PC is not anytime accompanying with the user. Even if the PC is with the user, it is not everywhere

turned on ready for use. PC allows user to access any information over Internet, of course, but not always online for access. Furthermore, PC is usually blocked out from business process by enterprise firewalls in order to prevent from non-business activities usages. Therefore PC is of less possibility of the mission-trigger advantage as well.

From commerce viewpoint, sales or services delivery are the basic transactions for enterprises to make profit. Consider a given e-commerce transaction to be accomplished. At the first glance, it seems that PC can help the buyer to access the information, and the automated e-process can assist the buyer to step through and complete the order placement. But, PC limits itself to comprehensive users, and is not easy to configure for Internet access. Even in the office, the only official available access tool is the office PC that certainly should be blocked out by corporate firewalls to prevent from unauthorized usages. Therefore, the most B2C activities have been blocked out and could not be realized. As a consequence, B2C e-commerce did not do well in the past.

However, B2B has always been very successful, and help enterprises reengineer the corporate. Although with only fixed-Internet connections, the introduction of Internet technology effectively coordinates the needs between the supplier and the business purchaser through fixed-location authorized business operations.

## 6. The Realization of Business Transactions

We have demonstrated how traditional e-business being blocked from timely matching the supply and demand for successful transactions in the B2C marketplace. However, how does mobile business overcome these obstacles? We will answer this question based upon transaction theory (Coase, 1937) and mobile business advantages.

Based upon transaction theory, a business operation can be viewed as a collection of business transactions, each of which is aimed to generate profits for the enterprise. Each business transaction can be decomposed into sub-activities, and be described by the following transaction model and transaction costs:

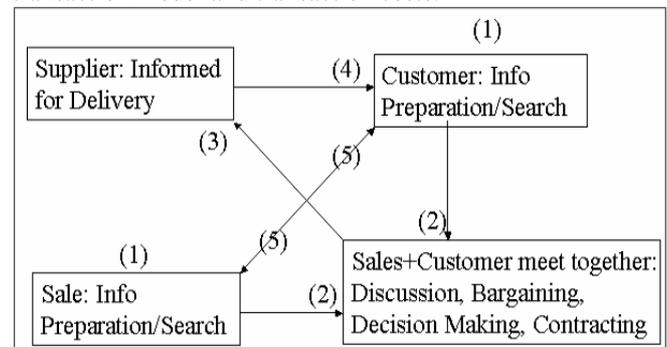


Figure: The transaction model with sub-activities and transaction costs

- (1) Information searching: Each customer searches for in-depth information about desired products/services and each sales agent searches for potential customers. During the process, we call this transaction cost the information cost,  $c_i$ , which includes both search cost and document preparation cost in a transaction.
- (2) Negotiation and decision making: With some information on hand, the customer and the sales agent communicate with each other either via telecommunications or via traveling to face-to-face meet-together for further discussion. In this phase, the sales agent and the customer discuss the case, negotiate for the prices, make decisions on appropriate choices, and finally settled with a contract. Besides the time spent in the process, the transaction costs involved are transportation cost,  $c_t$ , and telecommunication cost,  $c_v$ .
- (3) Informing the supplier: When the transaction reaches an agreement, the supplier, if needed, will be informed via transportation contact, telecommunication informing or digital document/data exchanges. The transaction costs involved are transportation cost ( $c_t$ ), telecommunication cost ( $c_v$ ), and information cost ( $c_i$ ).
- (4) Services/products delivery: The supplier delivers the services/products to the customer to fulfill the purchase transaction. The transaction costs involved are transportation cost ( $c_t$ ), telecommunication cost ( $c_v$ ), and information cost ( $c_i$ ).
- (5) Transaction management: During all process phases, it is enterprise's responsibility to monitor and administrate all activities in order to follow the transaction requirements. When the transaction service is fulfilled, it is enterprise's responsibility to maintain the customer's satisfaction. These transaction costs are the policing cost and enforcement cost, and will be denoted by management cost,  $c_m$ . The management cost covers the sales labor costs in our analysis for convenience.

Based on the above analysis, the total transaction cost,  $c_T$ , consists of the following components:

$$c_T = c_t n_t + c_v n_v + c_i n_i + c_m (t_a + t_1)$$

where,  $n_t$ ,  $n_v$ , and  $n_i$  are the frequencies of transportation, telecommunications and information retrieval/preparation costs, respectively, and  $t_a$  is the active processing time and  $t_1$  is the time lost during the transaction process.

According to the transaction model, the total realized profit can be described by the following equation:

$$\pi = (p - c_p - c_T) r q$$

where,

- $\pi$ : the total profit of all e-business transactions
- $p$ : the sales price

$c_p$ : the product cost

$r$ : the probability to realize a transaction and close the deal

$q$ : the potential quantity of transactions to the enterprise

In other words, the total realized profit equation could be restated as follows:

$$\pi = \{p - [c_p + c_t n_t + c_v n_v + c_i n_i + c_m (t_a + t_1)]\} (r_b r_t r_w r_e) q$$

## 7. How Mobile Technology Impacts Business Operations

Recall that mobile technology provides us with anybody, anytime, anywhere, any information, any process and mission-trigger advantages. These advantages empower both suppliers and customers to reach each other without been blocked-out. Given the above stated profit realization equation as well as the mobile advantages, therefore, we may analyze how mobile technology impacts business operations.

**Mobile Business Strategy 1: Reducing transportation activities by utilizing mobile communications, mobile Internet information retrievals and process assistances.**

First of all, we have analyzed the transaction costs and classify them into four categories, namely, the costs of transportation, telecommunications, information and management. Among these costs, traditionally, the information cost is the most expensive one, and transportation cost is the least, i.e.,  $c_i \gg c_v \gg c_t$ . Therefore people tend not to use technology.

However, with given Internet and mobile phone infrastructures development, the transportation cost becomes the most expensive one, and is significantly higher than those of telecommunications cost and information cost. For instance, transportation cost of each round trip tour to see a customer in Taipei City, besides about forty minutes or more time lost, is about 300 dollars. However, each 20-minute mobile call costs about 150 dollars, and the information retrieval cost is significantly less. In other words,  $c_t \gg c_v \gg c_i$  if mobile business is adopted. Therefore, it is not only clever to reduce the frequencies of each cost, but also clever to further replace transportation frequencies by telecommunications or mobile Internet information retrievals.

**Mobile Business Strategy 2: Reducing active processing time and eliminating time lost by meeting customers at effective location, closing the deal in an efficient manner and greater customer satisfaction, and utilizing unavoidable traveling time for other transactions scheduling or coordination by mobile communications.**

The time required to accomplish a transaction is another important factor to reduce the transaction cost. One can reduce the active processing time,  $t_a$  and the time

lost  $t_1$  with mobile technology. Anybody (either sales agent or the customer) can prepare sufficient information back and forth over Internet, anytime, anywhere, and settle the deal much more effectively. This will greatly reduce active processing  $t_a$ . As to the time lost, choosing an appropriate location with the customer with mobile technology for better communications and sufficient information, then one can concurrently coordinate simultaneous transactions to reduce the time lost dramatically, and furthermore gives much better customer satisfaction.

**Mobile Business Strategy 3:** Mobile technology gives much better possibility of getting the right persons, at right timing, in an appropriate location with right information to assist and settle down business contracts.

As described earlier, the probability of having a transaction to be successfully accomplished is  $r = r_b r_t r_w r_i r_e$ , where  $r_b, r_t, r_w, r_i, r_e$  are the probability of the right persons, right timing, right place, right information and assistance to execute, respectively. The third area to improve the business operation is to increase each of the probabilities by utilizing mobile technology.

It is worthwhile to point out that if the possibility of each of the 5 factors is increased by a factor of 2, then the total possibility is improved by a factor of  $2^5=32$ , which is a significant improvement to corporate profit realization.

**Mobile Business Strategy 4:** To increase realized transaction quantity and to lower unit cost can be achieved by adoption of mobile technology.

The last part in the profit realization equation is the realized transaction quantity. Note that the maximum quantity that a corporate can serve is the total working hours divided by the total processing time for each transaction. Denoted by  $T$  the working hours per month, then the maximum quantity that the corporate can serve per month is given by

$$r q = T / (t_a + t_1).$$

In other words, the shortened processing time significantly increase the capability of product selling. Furthermore, note that the product cost  $c_p$  is a function of realized transaction quantity  $rq$ , due to quantity discount:

$$c_p = f(rq),$$

where  $c_p$  decreases when  $rq$  increases.

With mobile business advantages, it is much easier to realize transaction quantity. An enterprise hence may expand the transaction volume easily, especially if the others have not yet done so. For newly startup mobile business, it is easier to reach critical amount of business transactions, and hence help entrepreneur. Given increased realized transaction quantity, therefore, it is easier to accumulate bargaining powers for discounted volume cost  $c_p$ .

**Mobile Business Strategy 5:** Mobile business is a must to competitive corporate. Because mobile phones are easy to use to anybody, the assigned mission can trigger the

responsible persons to execute accordingly. As a consequence, every competitive corporate will adopt mobile technology into operations, due to intensifying global competition.

Another fundamental question is: what are the prerequisites or sufficient conditions for an enterprise to adopt mobile technology to turn into a mobile business?

In traditional e-business environment, the implementation of e-business requires a lot of obstacles, such as highly educated computer employees and customers, only office or certain restricted places are equipped with internetworking infrastructure, etc. In mobile business, the capable persons are expanded those who use mobile phones, which is about 10 more time of PC users. Because of this anybody advantage, it is 10 times easier to hire qualified employees. Furthermore, it is easier to have a qualified CEO for such mobile business strategy planning and implementation as well.

Finally, substituting of above equations,  $r q = T / (t_a + t_1)$ , into the profit realization equation, we have

$$\pi = \{ p - [c_p(q) + c_t n_t + c_v n_v + c_i n_i + c_m (t_a + t_1)] \} (r_b r_t r_w r_i r_e) [T / (t_a + t_1)].$$

This equation states the relevant components that may be used to improve business operations by adopting mobile technology.

## 8. Concluding remarks

In the last decay, the e-commerce just got started, and gave traditional business great competition pressure. However, the Internet customers are usually blocked away from freely accessing and placing purchase orders at wills. On the other hand, the traditional business had already controlled most product supplies, and had tried hard to compete with Internet e-business. As a consequence, the first wave Internet e-business were difficult to realize business transactions, and did not survive to make enough profit. Therefore, most of DOTCOM enterprises were shaken out, and caused global economy recession.

In this paper, we analyze and propose the advantages of mobile business, namely, anybody, anytime, anywhere, any information, any process and mission-trigger. These fortes are available only in the newly developed mobile business environment, and can bypass the problems of being blocked out from realization over the Internet marketplace that traditional e-business had suffered.

The mobile technology significantly impacts business operations, and we can have the following strategies to improve business efficiency. We can utilize mobile technology to help corporate (1) lower all kinds of transaction costs, (2) shorten transaction processing time or time lost, (3) increase the probability for reaching agreement and getting settled with better customer satisfactions, and therefore (4) can handle more customer requests and lower the unit product cost. Furthermore, due to the easy to use/implement nature, mobile technology

can be easily adopted by most corporate, and hence (5) the mobile business adoption is a must to modern business operations.

This paper provides a framework for enterprises to utilize mobile technology and reengineer business process. Top management can therefore set up corporate strategies to restructure the enterprise resources, build superior core competence, and enhance compete in the global market.

## References

- [1] Coase, R. H., "The Nature of the Firm", *Economica*, Vol. 4, 1937.
- [2] Fitzgerald, J. and Dennis, A., "Business Data Communications and Networking", John Wiley & Sons, Inc., 2002.
- [3] May, Paul, "Mobile Commerce: Opportunities, Applications and Technologies of Wireless Business", Leviathan Publishing Company, 2001.
- [4] Stalling, W., "Business Data Communications", Prentice Hall, 2001.
- [5] Takeshi, Natsuno, "i-Mode Strategy", NIKKEI BP PLANNING, Inc., Tokyo, 2000.

# A Research on the Relationship between Marketing Channel Context and Channel Performance X> An Empirical Study into Mobile- Phone Firms between Taipei & Beijing

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## Abstract

This research has developed an analytical framework, which incorporates four measurement variables for a competitive marketing channel, they are channel structure, channel power, channel climate, and channel performance. Based on the questionnaire and personal interview, an empirical survey on mobile phone marketing channel located both in Taipei and Beijing was applied for system survey. SPSS statistical software tool was applied for survey data analysis with the functions of factor analysis, T test analysis, Pearson correlation coefficient analysis, and regression analysis. The major conclusions are summarized as followings: 1. Channel structure has significant influence on channel performance. 2. Channel power has significant influence on channel performance. 3. Channel climate has significant influence on channel performance. 4. Channel structure has significant influence on channel power. 5. Channel power has significant influence on channel climate. 6. Channel structure has significant influence on channel climate. Through the data surveyed, it is sufficient for us to make the characteristics comparison of marketing channel located in Taipei and Beijing. Channel management, information, protectionism and customer response speed etc. are the major problems occurred in China now.

Key words: Marketing channel, Channel structure, Channel power, Channel climate, Channel performance

## 1. Introduction

In the era of new economy, the life cycle of most products became shorter and shorter due to the continuous developing of information technology. In recent decades, the progress of industry developing in Taiwan is marching on the direction of high technology and high value-added precision industry, information communication is the most outstanding one especially. On situations of mature technology applied to the products of relative competitors, as well as the variety of customer demand, marketing channel has become the new policy for success. In adapting to this fluctuating marketing environments, to create a competitive marketing channel is the major business strategy, also it is the core capability and the critical successful factor for corporations in this new coming era.

China has borne the most attractive economic power

all over the world since 1979, the year of open, for her marvelous population and high economic growth rate. China has been the member of WTO (World Trade Organization) in 2002, that should lead China to adjust her economic developing style from production-oriented to customer-oriented, reduce and release the barrier of government regulation. Free trading, global marketing and global information flow should be the future trend for China. In the coming future for the corporations to win in China, it is the first consideration to build a strong marketing channel, then, they can grasp the keys to success.

Government regulations on telecommunication have been released step by step both in China and Taiwan. The opening on this new application area induces many new profitable business, business on internet, mobile phone, fixed network and broadband network are some typical applications. Due to the huge marketing capacity and high developing potentials in China, it's of no doubt for many competitors to share this "big pie" from both local and foreign corporations.

Taiwan and China are separated by Taiwan Strait, the distance is short geographically across the strait, but it's long in economic environments. Due to the difference in political and civil situations, the trading and marketing circumstance are quite different. This research has developed an analytical framework based on the questionnaire and personal interview, SPSS statistical software tool is applied for survey data analysis. The three major goals for this research are: (1) Survey on the relationship between marketing channel structure and marketing performance for retails of mobile phone in Taipei (Taiwan). (2) Survey on the relationship between marketing channel structure and marketing performance for retails of mobile phone in Beijing (China). (3) Compare and tell the difference in marketing channel structure and marketing performance between Taipei and Beijing.

## 2. Literature Review

This section will describe the definitions of marketing channel, channel structure, channel climate, channel power and measurement of channel performance. The corresponding literature reviews are summarized as Table 1.

Table 1 Characteristics of marketing channel

Topic	Brief Concept	Authors
Channel Structure	Divide into three major types based on processing functionalities: marketing trading, intermediate trading, hierarchical trading.	Owyer et al. (1981)
	Describe channel structure based on the level of intermediate trading: 0-level channel, 1-level channel, 2-level channel ...	Kotler (1997)
Channel Climate	Encourage the members of marketing channel to bear the feeling of mutual support based on the arrangement of partnership.	Rosenbloom (1987)
	The relationship among all members of marketing channel.	Reve & Stern (1986)
	Maintain a permanent partnership based on strategic consideration for the purpose of close and stable relationship.	Sheth (1994)
Channel Power	The control power of marketing channel strategies that one member of marketing channel overrides the others. This power can influence the decisions of total channel.	Stern et al. (1996)
	The source of channel power comes from the power perception of channel members. The common value and self-regulated rules generated through indirect and non-economic factors can influence the channel members with less disputable.	Lusch (1998) Rosenbloom (1987)
Channel Performance	Channel performance measurement should be built with multiple attributes and multiple levels' structure.	Stern et al. (1996)
	Review on the performance of retails based on the viewpoint of suppliers, there are four review modules: rationality system, behavior system, inner process system, open system.	Kumar et al. (1992)
	Review on the performance of wholesales based on the viewpoint of manufacturers, the quantitative index on profit rate and growth rate are the majors.	Kotler (1997)

A. Marketing Channel: The construction of all members who process the trading activities of goods or services from original providers to end consumers (Kotler, 1997). Trading process includes physical distribution, property transferring, payments, information exchange, risk management. The channel emphasize on the transferring process from providers to customers.

B. Characteristics of Marketing Channel

There are three major factors which compose the characteristics of marketing channel, they are channel structure, channel climate and channel power, all of these factors may have the critical influence to channel performances.

B-1. Channel Structure: The channel types that express how the marketing channel works.

B-2. Channel Climate: The perception of interrelationship among members of marketing channel.

B-3. Channel Power: The member who bears the control power over the others to influence the strategic activities of total marketing channel.

C. Measurement of Channel Performance: The outcome structure of total marketing channel as well as the performance measurement of their corresponding performance index.

3. Research Methodology

3.1 Survey Structure and Hypothesis Test

The three major characteristics in marketing channel has been discussed in the previous section. Figure 1 demonstrates the interrelationship among the three factors in marketing channel as well as channel performance. Based on the questionnaire and personal interview, we provide six hypothesis tests for system survey.

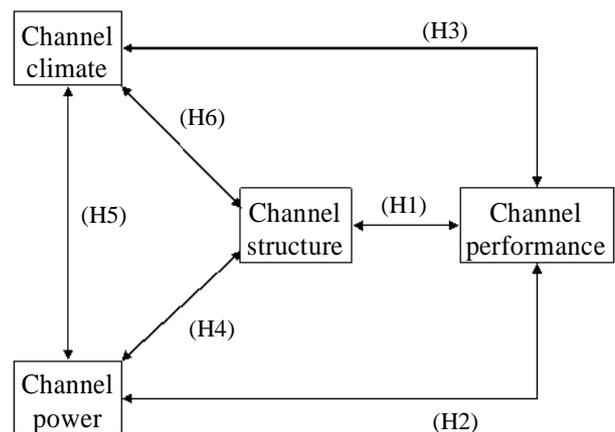


Figure 1 Survey structure

H1: Channel structure has significant influence on channel performance.

Channel structure has the sufficient influence on the characteristics of marketing channel and channel performance, communication styles are varied from one marketing channel to another (Rosenbloom 1987). On

the relational channel structure, the closer the channel relationship, the more the constructive communication is achieved (Etgar, 1997).

H2: Channel power is positively related to channel performance.

Channel power is defined as the decision variable that one member of the marketing channel has the power to control or influence on confidence, attitudes and activities of the others (Anderson et al., 2000; Stern et al., 1996). Channel power is positively related to the non-forced strategies of marketing channel (Brown et al., 2001). The higher the channel power appears, the more the non-forced strategies are applied on marketing channel (Mayo et al., 1998; Lusch, 2001).

H3: Channel climate bears the influence to channel performance.

Good channel climate will infer to good channel performance, that is strongly supported for all related literature survey on organization theory of marketing channel (Stern et al., 1996; Schul et al., 2001).

H4: Channel structure is significantly dependent on channel power.

There are mutual interrelationships between channel structure and channel power (Stern & Reve 1980). It is suitable to build up a marketing channel system based on centralized consideration in views of both channel structure and channel power, Under the marketing trading structure, the communication style will be collaborated if the channel power is symmetric, otherwise, it will be self-determined (Williamson 1981).

H5: The more effective of the channel power has the will to set a good channel climate.

“Trust” (Anderson, Lodish & Weitz, 2000) and “Permanent Relationship” (Hammond, Brown & Harmon 1996) are two critical variables affect the channel climate most. Trust is defined as the mutual self-regulated engagements or contracts, it is stable and reliable for all members of marketing channel, also, it is the commitment for every trading partner within a marketing channel. Permanent relationship refers to the perceptions of all trading partners in a marketing channel, they all have the will to maintain continuous and forever interrelationship (Hammond et al. 1996).

H6: Channel structure is significantly dependent on channel climate.

Members of marketing channel can process the relational exchange under the base of mutual support and full trust. Thus, the interrelation between channel climate and channel structure can catch its best effects. The more mutual confidence the members have, the more sufficient communication they do under the relational structure with climate of mutual support (Dwyer, Schurr & Oh 1981).

### 3.2 Data Collection

The survey population comes from mobile-phone retails located in Taipei and Beijing, the major retail

categories include IT (Information Technology) shopping malls, 3C (Computer, Communication, & Consumer Electronics) shops, chain stores and individual retailers. Survey data is randomly sampled proportional to its population and density of business activities, data is collected through personal interview. We issued 125 samples in Taipei and 116 samples in Beijing, 113 and 101 effective data is successfully collected, respectively.

The content of survey questionnaire data is focused on channel relation between mobile-phone manufacturer and retail, one unique manufacturer (brand) and one retail are set to be a survey “entity”, with which we can catch the relationship among channel characteristics and channel performance. The statistical software tool SPSS for Windows with version 10.0 is used for corresponding data analysis, it is also applied for variables validity and reliability assured.

### 4. Data Analysis

There are four characteristics considered in questionnaire design, they are channel structure, channel power, channel climate and channel performance. There are four, thirteen, eighteen and eight attributes contained in each characteristic respectively (see Table 3 - Table 6). Survey data is measured in Ordinal Scale (1, 2, 3 ...) for channel structure, the others are measured according to Likert's 7 grading scales (e.g. 1 represents extremely satisfaction, 7 represents extremely dissatisfaction). We issued 125 samples in Taipei and 116 samples in Beijing, 113 and 101 effective data is successfully collected, respectively.

The basic types of channel structure are similar on mobile phone marketing located in Taipei and Beijing, the upper lever (1-level) includes manufacturers and agents owned by local or foreign corporations, the middle level (2-level) is distributors, and the lower level (3-level) is retails. Retails can be owned by various categories, they are individual retails, voluntary chain stores (VC), franchise chain stores (FC), regular chain stores (RC) owned by manufacturers, agents, and mobile service company. The communication type is direct and fluent between members of level-1 and level-2, level2 and level-3, also, members of level-1 can contact with members of level-3 and catch sufficient information through telephone, facsimile, meeting, and personal contacts. Distributors play the roles of intermediate linking functions for both material flow and information flow, the major objective for distributors is to increase distribution efficiency, reduce total inventory, and reduce business risk.

SPSS statistical software tool is applied for survey data analysis: 1. Factor analysis is used for channel structure declarative data analysis. 2. T test analysis is used to review whether channel characteristics and their relative attributes have significant difference. 3. Pearson correlation coefficient analysis is applied to review whether the data among all characteristics of marketing channel is significantly dependent. 4. Regression analysis answers the questions about “What's the relationship between each pairs of marketing

channel's characteristics?" and "How about the degree of correlation?".

#### 4.1 Declarative Data Analysis of Channel Structure

Declarative data analysis is based on the types of retail (5categories) located in Taipei and Beijing, Table 2 summarizes the survey data of channel structure between Taipei and Beijing. The major difference occurred is that VC and FC stores take the brief portions (37.17%) in Taipei, while individual retails in Beijing win the top (42.57%). Due to the progressing of standardization on mobile phone industries, specialization, scale enlargement, and centralized control should become the new tendency, thus, IT shopping mall, 3C shops, VC and FC stores, and RC owned by telecommunication service company, will take major portion of channel structure in the near future. The channel structure developed in Taipei is earlier than which in Beijing, it tells the reason why the difference occurred.

Table 2 Channel structure summary (Taipei vs. Beijing)

Type of retails	Number		Ratio (%)	
	Taipei	Beijing	Taipei	Beijing
Individual retails	29	43	25.66	42.57
VC or FC stores	42	24	37.17	23.76
RC owned by agent	31	21	27.43	20.79
RC Owned by mfg.	4	3	3.54	2.97
Others	7	10	6.19	9.90
Total	113	101	100	100

#### 4.2 T-test on Channel Characteristics and Their Relative Attributes

T-test is used to review whether the data of two areas (Taipei and Beijing) has significant difference according to attributes within each characteristic of marketing channel (see Table 3 - Table 6).

##### 4.2.1 Attributes of Channel Structure

Survey data is measured in Ordinal Scale. Table 3 shows the summarized analysis results, the content of each attribute is described as follows:

- Retails Types: 5 categories are divided and refer to: 1. individual retailers, 2. VC and FC stores, 3. RC owned by agents, 4. RC owned by manufacturers, 5. others.
- Retails Location: the place where mobile phone products are sold. 1. IT shopping malls, 2. VC and FC stores, 3. 3C shops, 4. RC owned by telecommunication service company, 5. individual retails, 6. others.
- Ordering Types: set up a replenishment order, 1. to manufacturer directly, 2. not to manufacturer directly.
- Ordering Methods: the way setting up an order from retailer to manufacturers, 1. by telephone, 2. by facsimile, 3. by post mail, 4. by EOS (Electronic Ordering System), 5. through internet, 6. others.

Table 3 T-test on attributes of channel structure

Attributes	Average		S.D.		Avg.	S.D	T Value
	Taipei	Beijing	Taipei	Beijing			
Retails type	2.78	2.26	1.61	1.02	2.52	1.32	2.79*
Retails location	2.84	3.03	1.41	1.63	2.94	1.52	-0.90
Order to mfg.	1.00	1.01	0	0.10	1.01	0.05	-1
Ordering method	3.77	1.93	1.06	1.16	2.85	1.11	11.96**

Remark: \*\* Means  $P < 0.01$  \* Means  $P < 0.05$

##### 4.2.2 Attributes of Channel Power

Survey data is measured according to Likert's 7 grading scales. Likert's 7 grading scales refer to 1. extremely satisfied, 2. very satisfied, 3. satisfied, 4. fair, 5. unsatisfied, 6. very unsatisfied, 7. extremely unsatisfied. Table 4 shows the summarized analysis results for significant items only.

Table 4 T-test on attributes of channel power

Attributes	Average		S.D.		Avg.	S.D	T Value
	Taipei	Beijing	Taipei	Beijing			
Technical support	5.82	4.14	1.44	1.08	4.98	1.26	1.84*
Policy and procedure of order-return	4.50	4.23	1.40	1.18	4.37	1.29	-1.51
Fair price negotiation	4.04	4.66	1.30	1.16	4.35	1.23	3.66**
Strict punishment on counter-regulation	5.54	5.86	0.98	1.20	5.70	1.09	2.13*
Support on marketing strategies and competition information	5.44	5.78	1.04	1.10	5.61	1.07	2.30*
Mutual discussion on business strategies	5.38	4.02	1.30	1.30	4.70	1.30	3.55**
Show expectation only, no incentive, no punishment	5.42	4.12	1.59	1.44	4.77	1.52	3.37**
Hint on "accept my suggestions, comes more profit"	5.46	4.14	1.33	1.32	4.80	1.33	3.74**
Feedback business information periodically	5.41	4.46	1.57	1.29	4.94	1.40	5.36**

#### 4.2.3 Attributes of channel climate

Survey data is measured according to Likert's 7 grading scales referring to 1. extremely satisfied, 2. very satisfied, 3. satisfied, 4. fair, 5. unsatisfied, 6. very unsatisfied, 7. extremely unsatisfied. Table 5 shows the summarized analysis results for significant items.

Table 5 T-test on attributes of channel climate

Attributes	Average		S.D.		Avg.	S.D.	T Value
	Taipei	Beijing	Taipei	Beijing			
Commit to business strategies	5.71	4.06	1.37	1.07	4.89	1.22	2.06*
Manufacturer is royal	5.53	4.33	1.36	1.20	4.83	1.28	4.58**
Adaptable to environments	3.66	4.12	1.29	1.07	3.89	1.18	-2.83**
Take care on retail's business troubles	5.35	4.23	1.20	1.20	4.79	1.20	5.34**
Provide resource support	6.88	5.92	1.01	1.08	6.40	1.05	7.14**
CIS of mfg. is good to benefits	5.15	4.57	1.46	5.54	4.86	3.50	2.47*
Desire to maintain permanent relationship	5.06	5.68	1.19	1.32	5.37	1.26	3.53**
Keep mutual cooperation with mfg.	5.25	4.00	1.14	1.07	4.63	1.11	4.92**
Acknowledge to keep permanent relationship	5.08	5.87	1.27	1.28	5.48	1.28	4.47**
Willing of permanent contracts	6.84	4.09	1.32	1.28	5.47	1.30	6.99**
High degree of team-work	5.05	4.34	1.26	1.22	4.70	1.24	7.55**
Share the common benefits	6.74	4.38	1.37	1.28	5.56	1.33	8.98**
Keep good partnership atmosphere	5.01	4.02	1.14	1.36	4.52	1.25	5.82**

#### 4.2.4 Attributes of Channel Performance

Survey data is measured according to Likert's 7 grading scales referring to 1. extremely satisfied, 2. very satisfied, 3. satisfied, 4. fair, 5. unsatisfied, 6. very unsatisfied, 7. extremely unsatisfied. Table 6 shows the summarized analysis results for significant items of channel performance.

Table 6 T-test on attributes of channel performance

Attributes	Average		S.D.		Avg	S.D	T Value
	Taipei	Beijing	Taipei	Beijing			
Satisfy on current ROI	6.77	5.30	1.11	1.17	6.04	1.14	3.39**
Satisfy on current marketing shares	5.21	5.52	1.20	1.03	5.37	1.12	2.01*
Sales is grown up stably	5.71	4.05	1.14	1.24	4.88	1.19	2.10*
Achieve average inv. requested by manufacturer	5.70	4.32	1.41	1.25	5.01	1.33	3.42**
Achieve sales performance requested by mfg.	5.52	4.33	1.39	1.29	4.92	1.34	4.42**
Wills to keep continuous cooperation with mfg.	5.29	5.85	1.66	1.41	5.57	3.07	2.62**

T-test is also used to review whether the data of two areas (Taipei and Beijing) has significant difference according to each characteristic of marketing channel, Table 7 lists the summarized results on four characteristics of marketing channel. Based on the analysis results listed at Table 7, it is clear to find out that there exists significant difference ( $P < 0.01$ ) between Taipei and Beijing in every characteristic of marketing channel. The difference in channel structure may be caused by the business revolution on channel structure, business tendency to chain store system and large-scale shopping malls, difference in economic policies and consumption attitudes.

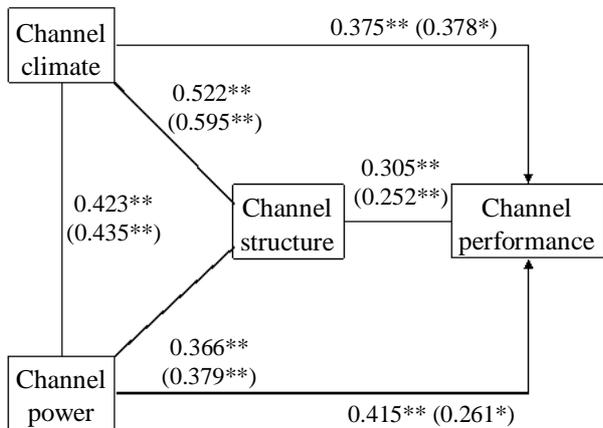
Table 7 T-test on characteristics of marketing channel

Characteristic	Avg.	Taipei	Beijing	Difference	T Value
Channel structure	6.33	6.60	6.06	0.54	6.30**
Channel power	4.83	5.65	4.01	1.64	3.67**
Channel climate	4.67	5.30	4.04	1.26	9.43**
Channel performance	6.20	6.48	5.92	0.56	4.72**

#### 4.3 Pearson Correlation Coefficient Analysis

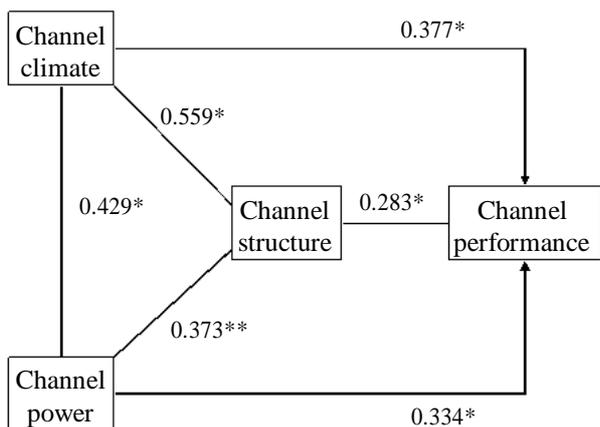
Pearson analysis is used to review whether the data among all characteristics of marketing channel is significantly dependent according to data of two areas (Taipei and Beijing) in individual and in summary. Figure 2 and 3 demonstrate the Pearson correlation coefficient in Taipei, Beijing, and summary, respectively.

The higher the value of correlation coefficient, the more correlated of the pairs. Based on Pearson correlation coefficient analysis, almost all the characteristics of marketing channel are mutually significant correlated.



Remark: \* P < 0.05, \*\* P < 0.01 ; the value in parentheses means Beijing.

Figure 2 Correlation coefficient for Taipei and (Beijing)



Remark: \* P < 0.05, \*\* P < 0.01

Figure 3 Pearson correlation coefficient (summary)

#### 4.4 Regression Analysis

Based on the results of Pearson correlation coefficient analysis, we find out that all the characteristics of marketing channel are mutually significant correlated, the advanced question is, What's the relationship between each pairs? How about the degree of correlation? Regression analysis is used to review, whether "yes or no" and how about, the assigned dependent variable (abb. Dep. V.) is varied proportional to the assigned independent variable (abb. Indep. V.).

All regression analysis on pairs of characteristics of marketing channel are listed at Table 8 – 10, they demonstrate the analysis results on channel structure, channel power and channel climate vs. channel performance (Table 8), channel structure vs. channel power (Table 9), channel structure and channel power vs. channel climate (Table 10), respectively. Based on the analysis data, we get a general conclusion as that, there is significant correlation between assigned independent

variables vs. dependent variables except "channel climate vs. channel performance".

Table 8 Regression analysis on channel variable vs. channel performance

Indep. V.	Dep. V.	Performance		
		(Taipei)	(Beijing)	(Total)
Channel structure	*Coefficient	0.312**	0.257**	0.285**
	R <sup>2</sup>	0.202	0.189	0.196
	Adjusted R <sup>2</sup>	0.196	0.173	0.185
	F Value	11.298*	7.044*	9.171*
Channel power	*Coefficient	0.412**	0.370**	0.391**
	R <sup>2</sup>	0.283	0.280	0.282
	Adjusted R <sup>2</sup>	0.253	0.241	0.247
	F Value	5.658*	5.653*	5.656*
Channel climate	*Coefficient	0.202	0.262	0.232
	R <sup>2</sup>	0.141	0.190	0.331
	Adjusted R <sup>2</sup>	0.133	0.178	0.156
	F Value	2.958	3.551	3.255

Table 9 Regression analysis on channel structure vs. channel power

Indep. V.	Dep. V.	Power		
		(Taipei)	(Beijing)	(Total)
Channel structure	*Coefficient	0.452**	0.433**	0.443**
	R <sup>2</sup>	0.336	0.323	0.330
	Adjusted R <sup>2</sup>	0.327	0.310	0.319
	F Value	8.738**	8.551**	8.645*

Table 10 Analysis on channel structure and power vs. channel climate

Indep. V.	Dep. V.	Climate		
		(Taipei)	(Beijing)	(Total)
Channel structure	*Coefficient	0.238*	0.278*	0.258*
	R <sup>2</sup>	0.176	0.179	0.178
	Adjusted R <sup>2</sup>	0.158	0.161	0.160
	F Value	6.634*	7.453**	7.044*
Channel power	*Coefficient	0.328*	0.319*	0.324*
	R <sup>2</sup>	0.169	0.157	0.163
	Adjusted R <sup>2</sup>	0.158	0.141	0.150
	F Value	6.534*	5.453**	5.994*

#### 5. Conclusions

This research has developed an analytical framework, which incorporates four measurement variables for a competitive marketing channel on mobile phone located both in Taipei and Beijing. According to 6 hypothesis tests listed at Figure 1, we get the conclusions that all characteristics (channel structure, channel power, channel climate) of marketing channel have significant influence on channel performance, and there are inter-relationship among channel characteristics.

The conclusions of data analysis in details are summarized as follows:

1. Channel structure has significant influence on channel performance.

On the relational channel structure, the closer the members of marketing channel are, the more effective

and cooperative communication they have (Brown 1981; Bharadwaj, Varadarajan & Fahy 1993; Colin 2000). We get the same conclusion as the result of literature review. There exists some basic difference between marketing orientation structure and relational channel structure, the closer the relational channel structure is, the more fluent communication, better negotiation, closer cooperative relationship they have, thus, will achieve better channel performance.

2. Channel power has significant influence on channel performance.

Based on the results of literature review, the dominating member exists in a marketing channel, will have the capability to build up a smoothing communication procedure and set up a good channel climate. It is not to abuse the rights one override another, but increase the power to influence the others, thus, it forms a good channel climate and improve the channel relationship. The strategies of dominating member can influence the total strategies of marketing channel through channel communication (Frazier 1983; Summers 1984). The higher degree of dominating power that one member has, the more probable that non-forced policy can be used (Lusch & Brown 1996). If the dominating member can use the power properly, then, they can march on the common goals and catch better channel performance under the situations of cooperative communication and close relationship.

3. Channel climate has significant influence on channel performance.

The members of marketing channel can achieve better team-work cooperation on the channel climate with higher mutual confidence and longer permanent relationship, which is similar to the conclusion surveyed (Anderson & Weitz 1989). If the better channel climate is built, the more smooth mutual communication will be, thus, increase the strength of team-work cooperation and channel performance.

4. Channel structure has significant influence on channel power.

Marketing channel of mobile phone is now progressing on the situations of continuous innovation, new incomer of channel structure impacts much on the current marketing channel, it cause the rearrangement of current channel structure, thus, it impacts the relationship of current channel power also.

5. Channel power has significant influence on channel climate.

Under the interrelationship between channel power and channel climate, members of marketing channel can choose either "go one's own way" or "mutual cooperation" while facing on issues of power conflict. If they choose mutual cooperation, then, it can reduce the negative effects caused which is similar to the conclusion surveyed (Kotler, 1997).

6. Channel structure has significant influence on channel climate.

On the interrelationship of channel structure and

channel climate, members of marketing channel bear the perception of common benefits, they are eager to create an atmosphere of mutual confidence, build up a relational channel structure, and set up a smooth communication channel. They all search for the goals of long-term channel performance, thus, can reduce the overall channel cost.

Marketing channel is a true business resource, to control the marketing channel means to handle the gate to customers, will hold the key to success. Communication industry is a great growth, giant changeable and quick customer response industry. In China, there are many shortcomings appeared, less efficiency transportation system, bureaucracy, protectionism and less operational efficiency are the majors, which should be improved much more.

The characteristics of marketing channel can be extended to a wide scope, the economic and social factor can be introduced in the future study, the more factors considered, the more complicated situation may be occurred, thus we can catch more in details. In the same way, this model can also be applied to various industries for advanced survey.

## Reference

- [1] Anderson, Erin; Leonard Lodish and Barton A. Weitz (2000), "Resource Allocation Behavior in Conventional Channels," *Journal of Marketing Research*, 22 (November), 365-76.
- [2] Brown, Robert F. Lusch, and Darrel D. Muehling (2001), "Conflict and Power-Dependence Relations in Retailer-Supplier Channels," *Journal of Retailing*, 59(Winter), 363-92.
- [3] Dwyer, F. Robert and Orville C. Walker (1981), "Bargaining in an Asymmetrical Power Structure," *Journal of Marketing*, 45(Winter), 104-15.
- [4] Etgar, Michael (1997), "Sources and Types of Intrachannel Conflict," *Journal of Retailing*, 55, 77-78.
- [5] Falcione, Raymond, Lyle Sussman, and Richard Herden (1987), "Communication Climate in Organizations," In *Handbook of Organizational Communication: An Interdisciplinary Perspective*. Eds. F. M. Jablin, L. L. Putnam, K. H. Roberts, and L. W. Porter. Newbury Park, CA: Sage, 195-227.
- [6] Kotler P. (1997), *Marketing Management*, Prentice Hill.
- [7] Kumar, Nirmalya, Louis Stern, and Ravi Achrol (1992), "Assessing Reseller Performance From the Perspective of the Supplier," *Journal of Marketing Research*, 29 (May), 238-53.
- [8] Lusch, Robert F (1998), "Channel Conflict: Its Impact on Retailer Operating Performance," *Journal of Retailing*, 52(Summer), 3-12, 89-90.
- [9] Lusch, Robert F (2000), "Intrachannel Conflict and Use of Power: A Reply," *Journal of Marketing Research*, 15 (May), 275-76.

- [10] Mayo, Donna T., Lynne D. Richardson, and James T. Simpson (1998), "The Differential Effects of The Uses of Power Sources and Influence Strategies on Channel Satisfaction," *Journal of Marketing Theory and Practice*, (4),16-25
- [11] Reve, Torger, and Louis Stern (1986), "The Relationship Between Interorganizational Form, Transaction Climate, and Economic Performance in Vertical Interfirm Dyads." In L. Pellegrini and S. Reddy, eds., *Marketing Channels*, Lexington, MA: Lexington Books, Institute of Retail Management, New York University, 75-102.
- [12] Rosenbloom, Bert (1987), *Marketing Channels: A Management View*, 3rd ed., NY: The Dryden Press.
- [13] Schul, Patrick, Taylor Little, and William Pride (2001), "Channel Climate: Its Impact on Channel Member Satisfaction," *Journal of Retailing*, 61(Summer): 9-38.
- [14] Sheth, Jagdish N. (1994), "Toward a theory of Relationship Marketing," Handout at the Relationship Marketing Faculty Consortium, Center for Relationship Marketing, Emory University.
- [15] Stern, Louis, Adel El-Ansary, and Anne Coughlan (1996), *Marketing Channels*, 5th ed. Englewood Cliffs, NJ: Prentice-Hall.

# Evaluation of M-Sites Using PDAs

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## Abstract

As mobile sites (m-sites) are introduced a very relevant question to ask is “How should these sites be different from the typical websites developed for desktop PCs?” This paper presents an initial, exploratory attempt to address some issues related to m-sites. This evaluation of sites was conducted using wireless PDAs in a WLAN environment. The results indicated that regular sites and m-sites differed significantly in perceived search engine functionality. The evaluated m-sites showed little differences across various industries. A discussion of these results as well as recommendations for managers and academic researchers are provided.

## 1. Introduction

According to the forecast of PriceWaterHouse Cooper [17], more users are expected to access the Internet in the future on mobile devices rather than on desktop computers. The report went on to predict that by 2005 the penetration of mobile data services in Western Europe will still lead the world (91% of its total population), followed by Japan (90%) [17]. United States, coming in third, will have increased its mobile data consumption up to about 83% while the worldwide penetration rate will be 20% [17].

As of September 2001, according to the National Telecommunications and Information administration [18], the vast majority of Internet users in the United States accessed the Internet through a desktop or laptop computer. Only 1.8 percent of households had an Internet accessible personal digital assistant (PDA) or

other handheld device. The other devices capable of accessing the Internet such as cell phones and pagers were only owned by 4.8 percent of households. Virtually, all of these households with mobile devices also had computers [18].

Mobile communication, since the 90s, has been evolving from voice only transmission to simple data transmission, followed by Enhanced Message Service (EMS) and then Multimedia Messaging Service (MMS) (See Table 1). MMS is classified as third generation (3G) cellular technology. Nippon Telephone and Telegram (NTT) DoCoMo system in Japan has successfully employed 3G technologies. The success of DoCoMo not only relied on its rollout of the infrastructure layers but its quality of service (QoS) in handhelds and content services – i-Mode which offers mobile websites and i-Appli offers more interactive applications [11]. Nationwide deployment of 3G in the U.S. was conducted by Sprint during the summer of 2002 tied with the release of Men in Black II, in which the company’s service was featured.

When discussing wireless research, the technical issues, such as the interoperability, have been the primary topics. However, there have been few known scholarly studies examining how website contents appear on the mobile devices. As m-sites are introduced a very relevant question to ask is how should these sites be different from the typical websites developed for desktop PCs? As shown in Table 2, accessing the Internet with m-devices is likely to be a very different experience for users compared to the experience with desktop computers.

Table 1 : Evolution from Text to Multimedia

	1990s	2001	2002
Characteristics	100-200 characters	Text messages, sound Picture, text formatting	Multiple rich media formats
Content reformatting for mobile necessary	Yes	Yes	No
Application	Simple person-to- person messaging	Person-to-person messaging	Person-to-person messaging with visual feel
Multimedia Messaging	All phones	EMS standard expected to be Widely adopted	MMS standard expected to be Widely adopted

Table content extracted from Lewis [15].

Further, although use of an m-device has one big advantage over PCs (mobility), it also has several disadvantages. Compared to desktop modem access, data transfer via mobile devices is more expensive. Compared to the rest of world, the majority of U.S. population still prefers the desktops over mobile devices to access information via Internet. Theoretically, regular Web and the mobile Web have distinct audiences, purposes and characteristics that supposedly warrant different features and content. In reality, how do sites compare at this point?

This paper presents an initial, exploratory attempt to address some issues related to mobile sites. How successfully are these changes from regular to “mobile” sites currently being made? How are users reacting to these mobile sites? What improvements appear to be needed? This paper will report on the analysis of over seventy sites and discuss managerial implications as well as recommendations for future studies.

Table 2: Contrast of Alternative Means of Accessing Internet

Attribute	Desktop Computer	Handheld devices
Connection speed	fast	Slow/moderate
Connection expense	cheap	expensive
Monitor size	large	small
Visual quality	great	poor
Sound quality	great	poor
Navigation ease	good	poor
Mobility	poor	good

## 2. Literature Review

Mobile websites (referred to here as the Mobile Internet) involve the use of wireless communications technologies to access network-based information and applications from mobile devices [17]. Customers engaged in m-commerce use wireless communication technologies to access network-based information and applications from mobile devices. Excluding laptops, there are currently two principal classes of mobile devices: mobile phone handsets and handheld computing devices (e.g., Personal Digital Assistants, PDAs). As shown in Table 2, analysts cited a number of obstacles to the development of the mobile Internet in the United States, such as minimal screens, low data rates (less than 20 Kbps), and cumbersome text input mechanisms [14][15].

In transition from regular web sites to presenting the content on the wireless platforms, such as Time Division Multiple Access (TDMA), Code Division Multiple Access (CDMA), and Global System Mobile Communications (GSM), the service providers have developed different ways to modify the presentation. Typically, regular web sites provide the same information

to the mobile sites. Sometimes, you may click through the mobile site via regular Web sites, for example, CNN, The Wall Street Journal (which is hard to navigate through). Some regular sites have distinctly different mobile sites to show their unique presentations on the wireless platforms.

There are several ways to develop wireless e-business applications (See Table 3), such as:

1. Create regular Web pages that users view from the small displays on mobile devices.
2. Using the Wireless Application Protocol (WAP) to connect to the Internet.
3. Build applications optimized for handheld devices using Web clipping.
4. Build a Native application that can incorporate on-line and off-line components and are available when network connections are not.

Table 3 : Wireless Development Option Comparison

Capabilities / application	Web pages	WAP	Web clipping	Native
<b>Data transfer</b>				
Multiple modes	No	No	Limited	Yes
Intelligent selection	No	No	No	Yes
<b>Data access</b>				
Local databases	No	No	No	Yes
Local processing	No	No	No	Yes
<b>Data interactivity</b>				
Rich display	No	No	Yes	Yes
Flexible input	No	No	Yes	Yes
Mobile computing	No	Yes	Yes	Yes
Intl coverage	Yes	Yes	Yes	Yes

Table content extracted from [16].

No matter what type the application is, there are different characteristics to define QoS. In terms of technology, QoS parameters may include timeliness, bandwidth, and reliability [5]. From the user’s point of view, QoS requirements may become a perceived QoS. Depending on the type of data transmission application, the priority can be defined among different flows in multimedia stream by picture resolution, color accuracy, video rate, video smoothness, audio quality, video/audio synchronization, cost and security [12].

Buchanan et al. [3], in their usability research of WAP phones, identified design guidelines which: 1) provide direct, simple access to focused valuable content, 2) use simple hierarchies, 3) reduce the amount of vertical scrolling, and 4) reduce the number of keystrokes. The study resembled issues identified during the early stage of website development for desktop computers.

Followed by Chan et al. [6] using cognitive walkthrough and heuristic evaluation methods, they evaluated the usability of ten wireless sites in three platforms: WAP-enabled mobile phones, Palm OS based wireless PDAs, and Pocket PCs running Windows CE operating systems. Their usability findings pertained to user tasks, content presentation, search, navigation

systems, and the design constraints imposed by form factors impacted on usability [6].

The research objective of Chan et al. [6] was to assess the usability of wireless sites of the most popular e-commerce companies as well as to provide the examination of wireless interface design. In defining wireless sites, their definition of tasks focused on transactional, and information retrieval. They found that all ten sites accessed using mobile devices were designed with steps similar to their counterparts designed for PC-based access [6]. However, in mobile environment, there was neither enough time nor content for users to perform such tasks. As insightful as this study was, only ten sites were evaluated. The very small number of sites could have greatly biased their evaluations. Further, it precluded their ability to make comparisons across industries.

Cellmania.com launched a free directory of 10,000 of the most “effective” WAP sites [2]. As a third party from the Web industry and consumers, Cellmania reviewed mobile sites with four criteria: overall usefulness to the mobile consumer, content, ease of use and navigation, interactivity and robustness of site. Thirteen categories were evaluated by the experts and users. Those categories are communications, travel, reference, news, games, financial/business, directory services, weather/traffic, sports, portals/search, m-commerce, food and entertainment [10]. Unfortunately, very little information about the analysis made by Cellmania.com was publicly released. Thus, we still do not know how sites optimized for mobile devices compare to those optimized for desktop PCs or what differences may exist across industries.

Given the previous work that has been conducted, two research questions were addressed in this research. First, what differences are there between the typical

websites constructed for the desktop experience and those sites designed with mobile devices in mind? The second question has to do with the possibility that some industries may be more innovative than others in preparing for this new form of Internet access. Thus, what differences are there between industries in terms of the ways their sites appear on a mobile device?

### 3. Methodology

The study was conducted with students in a MBA course at a large university in the Midwestern United States. The students were put into groups and provided some instruction on using the m-devices. They were each assigned seventy-four sites to evaluate and they were not told specifically whether the sites were regular or mobile sites. Reports in the popular press as well as the researchers’ experiences with the devices provided insight into the key problems that users could encounter at websites.

Thirty-four (See Table 4) out of over 600 mobile sites were filtered from Palm.net Web clipping services [9]. Forty regular websites in addition to the mobile sites were evaluated in this research (a total of 74). Five industries were chosen from Palm.net, whose sites were presented with average users’ ratings. Evidently, there were more regular websites than the mobile sites. Originally, the researchers selected more than 74 sites; however, some mobile sites were deleted because of their loading difficulty and/or unavailability when this research was conducted. Those sites may have been temporarily out of service or simply out of business because of economic downturn.

Table 4: The Evaluations of Websites and Mobile Sites in Five Industries

Industries	Entertainment	Finance	News	Shopping	Travel
Regular Websites	Dodgeball	Ameritrade	CNN	GapCo	eLocal
	Dorcino	BigCharts	ESPN	Amazon	Fodors
	Egolfscore	CBSMarketWatch	LATimes	InternetGroceries	Freightgate
	Fandango	NewYorkFed	AllLotto	BarnesNobles	HotelDiscounts
	Gorm	Forbes	CBS1	DealTime	NWAirline
	InterBUG	MasterCard	USAToday	eBay	OAG
	Moviefone	Quicken	VegasInsider	Godiva	PizzaOnline
	WellsFargo		BlueBook	Travelocity	
	FreeRealTime		Oreilly		
Mobile Sites	Banywhere	NewYorkFed	ABCNews	Amazon	CoTimetable
	Beamshop	Fidelity	AllLotto	Barnes&Noble	Freightgate
	booksbtc	Forbes	CNN	Buy.com	HotelDiscounts
	Dodgeball	MarketWatch	ESPN	eBay	NWAirline
	Dorcino	Quicken	InfoBrand	GoAmerica	OAG
	Egolfscore	WellsFargo	Chronical	Oreilly	
	Moviefone		CBS		
	InterBUG		VegasInsider		
	Airguitar				

The evaluations made by the judges addressed several issues. First, how well did the page fit within the screen when the respondents looked for a particular function like a “search engine?” Did the respondents need to scroll around on the minimized PDA to find the function? While meeting the task of “looking for a search function” on the sites, the respondents were asked to evaluate if the text was readable, and if the graphics were presented right. Finally, the respondents assessed how easily they found a search function. The rationale behind this procedure was that by completing a task - find a search engine, the respondents gave their quick responses to what was presented in a particular Web site, regular or mobile.

The m-devices used in the study were PDAs. Specifically, they were a top-of-the-line color version running Pocket PC with Microsoft CE including Internet Explorer. The devices connected to the web via “Wi-Fi” (802.11b) network. The screen size was approximately 3” x 2”. Although it would have been valuable to use 3G cell phones, at the time the study was conducted cell phones with Internet services were still rare in the U.S., not to mention the difficulty and expense of obtaining enough handsets and service to use in the exercise.

The URLs for the sites were put in the Favorites folder of each device ahead of time by the researchers. The procedure was for each site to be accessed using Internet Explorer and then for the questions to be answered. To make the job as simple as possible yet remain in the mobile domain, students used an Excel form created by the researchers running simultaneously on the PDA. By using programmable function buttons on the front of the devices, students could easily switch between a view of a website and the spreadsheet upon which they entered their assessments.

Once a group had finished judging all of the sites they e-mailed their Excel file to an address provided. The researchers then merged the data from each of the groups into one file and analyzed the data. T-tests were utilized to analyze the differences between the mobile sites and the regular sites. ANOVA was used to analyze the differences among the various industries. This study was not concerned about potential differences in group or individual evaluations but instead focused on differences between sites as judged by the groups.

#### 4. Results

The assessments of the five groups of judges of the seventy-four sites were analyzed to address the research questions. The findings with respect to each question are presented below.

#### Research Question 1: Mobile vs. Regular Websites

Surprisingly, there were few significant differences found between mobile and regular Websites. Among the site characteristics tested, we found that only the presence of a search engine showed a significant difference ( $t = 2.117, P < .05$ ). In other words, the regular websites (mean = 3.35) provided easier access to search engines than m-sites (mean = 2.96). The other criteria, adequacy of fit to the screen, degree of graphic distortion, and readability of text, did not show a significant level of difference between regular websites and mobile sites (See Table 5).

Table 5: The Differences between Regular & Mobile

	*Web/ Mobile	Mean	Std. Dev	t	df	Sig. (2- tailed)
Fit	Web	2.61	1.265	.065	365	.948
	Mobile	2.60	1.202			
Readable	Web	3.88	1.109	-.502	365	.616
	Mobile	3.94	1.056			
Distorted Graphics	Web	2.77	1.423	-.249	365	.803
	Mobile	2.81	1.488			
Search Engine	Web	3.35	1.782	2.117	365	.035
	Mobile	2.96	1.781			

Web N = 198; Mobile N = 169

#### Research Question 2: Differences among Industries

The sites were grouped into five industries: entertainment, finance, news, shopping, and travel. In Fit, Readable, Distorted Graphic, and Search Engine criteria, there were no differences among five industries using ANOVA (See Table 6). The researchers further ran the t-test on 14 paired industries to see if there were any differences. It turned out that, only two industries, finance (mean = 3.14) and shopping (mean = 2.40), showed significant differences ( $t = 2.184, P < .05$ ). Specifically, typical websites were viewed as different from m-sites in their degree of distorted graphics (See Table 7). Therefore, among those sites we evaluated, the sites in finance industry were more likely to present distorted pictures than those in shopping industry.

Table 6: The Differences between Industries

		Sum of Squares	df	Mean Square	F	Sig.
Fit	Between Groups	2.900	4	.725	.496	.739
	Within Groups	239.739	164	1.462		
	Total	242.639	168			
Readable	Between Groups	1.558	4	.390	.344	.848
	Within Groups	185.850	164	1.133		
	Total	187.408	168			
Distorted Graphic	Between Groups	12.080	4	3.020	1.376	.244
	Within Groups	359.861	164	2.194		
	Total	371.941	168			
Search Engine	Between Groups	10.277	4	2.569	.807	.523
	Within Groups	522.433	164	3.186		
	Total	532.710	168			

Table 7: The Differences between Finance and Shopping Industries

	Industry	Mean	Std. Dev	t	df	Sig. (2-tailed)
Fit	Finance	2.72	1.162			
	Shopping	2.37	1.159	1.183	57	.242
Readable	Finance	3.97	.981			
	Shopping	3.77	1.278	.669	57	.506
Distorted Graphic	Finance	3.14	1.529			
	Shopping	2.30	1.418	2.184	57	.033
Search Engine	Finance	3.31	1.775			
	Shopping	3.17	1.840	.305	57	.761

Finance N = 29; Shopping N = 30

## 5. Discussion

As more people begin to connect to the web using mobile devices than PCs the sites themselves will have to change. Chief among the changes noted in this study was ease of finding a search engine. It appears that right now it is much more likely to find a search engine at a normal site than at an m-site. Having an easy to find search engine is important even for those who access the web with desktop computers. But, for those using m-devices they are likely to be critical. That is because navigating around a site to locate something of interest is so difficult when the screen is small and the keyboard is limited or non-existent. When a search engine is not prominent upon reaching the front page of a site visitors could quickly become frustrated and go elsewhere.

Because of its distinct characteristics compared to regular websites, mobile sites will need to define further on QoS when the research related to content analysis, usability and websites development. The constantly changing mobile industries have several ways to create their m-sites. However, while Web clipping service providers offer a unique setting for the handheld optimization which utilizes synchronization function of PDAs, there are more disappointments on mobile devices than satisfaction. At least, our study made less dramatic evaluations. Different protocols and mobile applications appear to have made great differences in results.

No matter what type of application is used, there are different characteristics to define QoS. For example, in transferring an image file, the picture quality and the response time could be considered as appropriate factors [12]. In terms of technology, QoS parameters may include timeliness, bandwidth, and reliability [5]. From the user's point of view, QoS requirements may become a perceived QoS. Depending on which type of data transmission application is used, the priority can be defined among different flows in multimedia stream, e.g., picture resolution, color accuracy, video rate, video smoothness, audio quality, video/audio synchronization, cost and security [12]. For content delivery, a new breed of Mobile Internet Providers (MIPs) is filling the gaps over the airways until the new data networks are in place.

It has to do with the fact that users are unfamiliar with using the devices for data purposes and the devices are inferior to the desktop experience in many ways (as shown in Table 2). For those consumers who have alternatives, they may just continue surfing the Web using desktops until mobile devices overcome the barriers of human usability and technical difficulty. In addition, most websites are not constructed with m-devices in mind. Thus, this study examines some ways in which "good" and "bad" sites differ.

In general, most users expect a wireless website to be somewhere between the level of sophistication of an interactive voice response (IVR) system and a Web site [1]. Mobile devices, PDA, cell phone or pagers, have their limitations to the screen size and their cumbersome text input mechanisms. Despite the convenience, most U.S. consumers will probably continue using the easier and faster interface on their home computer until mobile devices overcome the current problems. Gillick et al. [7] suggested a speech recognition technology for text input on a very small mobile device. Cellmania [4], however, just introduced WebNum to the market that consumers can simply use numeric shortcuts associate with the Internet site's domain name to overcome cumbersome Web surfing by keying different sites.

Businesses servicing websites should develop their mobile Internet sites in both WML (wireless mark-up language) and HDML (handheld device mark-up language) to ensure their customers can access them despite the sort of mobile device they have. Moreover, marrying the company's website to the mobile one may

be useful in some cases so that some interactions can start on the desktop and finish on the phone and vice versa [1]. Meanwhile, the voice interface may be used to enhance the Internet access experience for speaking with a customer service representative but not losing their data processing. VoIP (Voice over IP) should be anticipated to provide data and voice messaging via mobile devices in the near future.

## References

- [1] Berry, Neerav. *Retooling for the Wireless Web: Is Your Business Ready for the Wireless Web? White Papers*, Cellmania. 2000.
- [2] Braue, David. *Cellmania Aims To Remove WAP Blockade In Telcos, Enterprises*. February 09, 2001. <http://www.wirelessauthority.com.au/r/article/jsp/sid/979490>
- [3] Buchanan, G., S. Farrant, M. Jones, H. Thimbleby, G. Marsden, and M. Pazzani, "Improving Mobile Internet Usability," *Proceedings of the Tenth International World Wide Web Conference*, New York, NY: ACM, 2001.
- [4] Canada News Wire. *Cellmania's mFinder(TM) Wireless Search Engine and Directory is Now Available to Rogers AT&T Wireless Customers Across Canada*. <http://www1.newswire.ca/releases/February2002/04/c8295.html>
- [5] Chalmers, D., Sloman, M. "A Survey of Quality of Service in Mobile Computing Environments," *IEEE Communication Surveys*, 1999. 2nd Quarter.
- [6] Chan, Susy S., Fang, Xiaowen, Brzezinski, Jack, Zhou, Yanzan, Xu, Shuang, and Lam, Jean. "Usability for Mobile Commerce Across Multiple Form Factors," *Journal of Electronic Commerce Research*, 2002, Vol. 3: 3.
- [7] Gillick, Kevin, Vanderhoof, Randy. *Mobile E-Commerce (m-commerce) "Market Place Enablers and Inhibitors" A White Paper for the Smart Card Forum Annual Meeting*. September 2000.
- [8] <https://ami.avantgo.com/channels/index.html>
- [9] <http://applications.palmsource.com/Software/index.asp>
- [10] <http://mfinder.cellmania.com/Jsp/web/home.jsp>
- [11] <http://www.nttdocomo.com>
- [12] Jamalipour, Abbas. "Wireless Broadband Multimedia and IP Applications Via Mobile ATM Satellites," In Sirin Tekinay (ed.) *Next Generation Wireless Networks*. MA: Kluwer Academic Publishers. 2001.
- [13] Kukitz, Jeff. *Online Initiatives of Top Business Schools: Best Practices*. PA: Penn State Publication. 2001. <http://www.ebrc.psu.edu/publications/researchpapers.html>
- [14] Lawton, George. "Waiting for wireless apps." *ZDNet News*. November 1, 2001. <http://techupdate.zdnet.com/techupdate/stories/main/0,14179,2821554-4,00.html>
- [15] Lewis, Valerie "Sensory Overload." *America's Network*, Sep 1, 2001, 105, 63-8.
- [16] Palm Inc. *Wireless Enterprise Applications for Mobile Information Management: Development Options and Business Decisions*. 2000. <http://www.palm.com/pr/palmvii/7whitepaper.pdf>
- [17] PowerWaterHouseCoopers. *Technology Forecast: 2001-2003*. CA: PowerWaterHouseCoopers Technology Center. 2001.
- [18] Victory, Nancy, & Cooper, Kathleen. *A Nation Online: How Americans Are Expanding Their Use of the Internet*. U.S. Department of Commerce/National Telecommunications and Information Administration. 2002.

# A SCADA Management Strategy for Mobile Industry

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## Abstract

Taiwanese mobile telecom industry encounters the difficult of operation and management due to the dispersing of mobile stations and telecommunication system in different areas. Therefore it is the important policy for mobile telecom that how to draft an effective operation method and to drop the cost of management and human resource.

The aim of this research is to study the operation and management cost reduction of the telecom industry through the supervisor control and data acquisition (SCADA) system application during globalization, privatization and liberalization competition. Yet this management system can be proposed functions: prevent faults, eliminating faults fast, operating monitor and to drop the cost of management.

Through literature and empirical analysis, the author found that the SCADA system is applied in telecom industry and mobile stations in Taiwan, the operation and management characteristics can be proposed as follows: (1) Macro Mobile Stations (2) Multi-Task and Multi-User (3) Line/ Modem, OA- LAN stability (4) Real time control program (5) System redundant.

Results indicated that the SCADA system has been highly willing to mobile and telecom industry in the development of power supply quality and to drop the operation and management cost. Also this research aims at measuring the benefit on SCADA system applications in mobile stations and to provide decision-makers and managers with useful operation and management strategies as reference.

Finally, the author suggests that the further research shall focus on the processing equipment characteristics and the management characteristics of other industry with large power demand. It is also desired that a feasible useful management strategy is developed to assist the other industry customer to reduce operation and management cost and to increase the competitive capability.

## 1. Introduction

### 1.1 Motivation

Before 1985, the reserved capacity of Taiwan Power Company (TPC) could stably and sufficiently supply the power consumption; our government didn't lay much emphasis on the development of load management policy

in power energy. It is therefore that the industries didn't pay much attention on their own power energy management procedures.

From 1985 to 1995, the rapid growth of economy as well as the prosperity of industry and commerce, which result in the increase of power consumption year by year. Besides the construction of nuclear power station and power transmission and distribution was conflict with the doubts of their safety and environmental pollution from the general public. Therefore the projects for power development were hampered by these difficulties and the power supply of on-peak hours was gradually insufficient. Thus our government emphasis on the load management of those industries with large power consumption in this duration. There are therefore many papers and relevant reports related to load management of power energy ready for reference [1][2][3].

Recently, Taiwan government has been putting lots of effort on joining WTO and developing the operation center of Asia Pacific area. With these regards, how to open Taiwanese telecom market to be freely and internationally accessed by other communities is an important issue. However, the government owned companies deliberate our steps for performing on the international stage, since they have been criticized with low operating performance. Therefore, how to privatize the government owned telecom industry efficiently and efficiently is of major interest for the government and public.

Taiwan telecom industry encounters the difficult of operation and management due to the dispersing of mobile stations and communication system. Therefore it is the important policy that how to draft an effective management method and to drop the cost of management.

The aim of this paper is to study the operation and management cost reduction of the telecom industry and through the SCADA system application during globalization and liberalization. Yet the system can be proposed functions: prevent faults, eliminating faults fast, operating monitor and to drop the cost of management.

Now SCADA system applies in telecom stations and mobile stations in Taiwan, the characteristics of management and operation can be proposed as follows: (1) Macro Mobile Stations (2) Multi-Task and Multi-User (3) Line/ Modem, OA- LAN stability (4) Real time control program (5) System redundant [4].

## 1.2 Trends and Drivers of the Telecom Industry

Trends of deregulation, technological advancement and privatization are causing turmoil in a once stable and highly profitable industry. The advent of competition is exerting continuous pressure on prices with margins falling as a result, and necessitates the introduction of value-added services to sustain volume and profitability. Asia has not been spared these trends, which are global and sweeping in nature. Technology is advancing, with new services such as Internet telephony threatening to gain substantial market share in domestic and international voice traffic at the expense of established telecommunication companies. The pressure will most be felt in international traffic which produces only an estimated 12-15 percent of the revenues of the big operators but 30-40 per cent of profits [5]. Internet telephony is forecast to account for as much as 15-30 per cent of the market for voice and fax calls within five years. Internet telephony is inexpensive, and allows segmentation of the market, where consumers can choose the level of service they require and be charged accordingly. It also enables the provision of several value-added services to consumers, for example real-time billing, cheaper video-conferencing and shortly unified messaging.

In Asia, Internet telephony is said to be a "regulatory minefield", with some countries banning it, others embracing it and some unsure as to how to handle it [6]. Such technological improvements are a huge threat, but also an opportunity for the companies which can be entrepreneurial and innovative enough to invest in and develop further this technology, in an industry shifting from proprietary to open standards, as happened to the computer industry in the 1980s. To become effective competitors in such conditions would require a cultural change for most telecommunication companies, historically operating in a slow-moving, monopolistic and protectionist world. The idea is to create a company run by people who think in terms of a world where the ratio of performance to price doubles every 18 months, and where deals have to be snapped up at once" [7]. Such a cultural change is difficult to achieve; British Telecom, for example, has not made a serious effort at such change, until its dominance in international phone traffic in the UK has been seriously threatened during the last two years [8][9].

The huge overcapacity in telecom, intensifying competition, as well as the Asian financial crisis, are increasing the pressure for consolidation in the Asian telecom industry, where stronger companies may acquire weaker ones, especially newer competitors recently awarded telecom licenses. One interesting outcome of the crisis is that it gives some breathing space to the established players, since challengers find it much harder to realize their expansion plans [5].

The above trends in the telecommunications industry are expected to continue in the future, with even more substantial effects on the telecom companies. The Asian

competitive climate in this industry differs in some respects, such as the vast infrastructure investments that have to be carried out in order to improve teledensity rates and service availability and quality. Future trends in Asian telecommunications include those listed in Table 1.1 [10].

Table 1.1 Trends in Asian Telecommunications

1. Strong growth of fixed line and mobile telecommunications networks due to low teledensity rates (Taiwanese mobile telecom networks are higher)
2. Acceleration of deregulation and privatization and the resulting increased competition
3. Concession/licensing periods of 15-25 years utilizing the Build-Transfer-Operate model or a variation thereof
4. Strong demand for debt and equity capital to finance expansion
5. Industry rationalization through mergers and acquisitions
6. Technology trends and their pricing impact

## 1.3 Characteristics and Environment of the Telecom Industry

The trends of business globalization in the late twentieth century enhance the centralization among industries and therefore form business conglomerate. In the latest survey of top-fifty business conglomerate by Common-Wealth Magazine, those industries such as consumer electronics, computer, and communication which are also known as 3C industries were all except communication on the survey lists; however, the communication manufacturing industry which is the most protective industry in Taiwan was excluded from the survey lists.

Since the revenue of their products ranked top 10 around the world in 1985, the information electronic industries have become the benchmarking industries in Taiwan. Besides, the potential markets arising from telecommunication liberalization and privatization have brought the number of information electronic industries into the R&D and manufacture of telecommunication products. And moreover, the widespread applications of Internet help integrate information and communication technologies. Under the trends of the above development, this research considers the managerial strategies of information electronic industry as the basis of investigating strategies of communication manufacturing industry.

In Taiwan, government policies play an important role in the development of communication manufacturing industry. And those impacts can be summarized as six dimensions there are:

(1) The monopoly of telecommunication service business;

- (2) Dual roles of Directorate General of Telecommunication as operator and supervisor;
  - (3) Business managerial model determined by procuring policies of government's telecommunication equipment;
  - (4) Deeply politic- economic involved digital switching industry;
  - (5) Transmission equipment industry which is regulated by government procurement policies;
  - (6) The first liberalized telephone set industry.
- Taiwanese telecom operates under very different conditions from the telecommunications providers in the rest of Asia.

## 2. A SCADA Management Framework Application in Mobile Industry

### 2.1 The Management Strategy of the SCADA System

In recent years telecom industry has experienced an unprecedented degree of change in management, process technology, customer expectations, supplier attitudes, competitive behavior and many more aspects. Indeed all the evidence suggests that change is now a permanent feature of business environment and that companies which can adapt to this new environment are likely to gain significant competitive advantage.

Thus, using the Porter (1980) generic strategies as a simple illustration, a firm operating an unfocused, differentiated strategy might also be capable of operating a focused differentiated strategy, but not for example an unfocused, least cost strategy [11]. Some transitions between strategies will be relatively easy, others will be more difficult. Abell (1979) suggests that strategy space can be represented as comprising a number of dimensions which might be market, product or technology groups. Within each dimension a number of levels will be open to the organization depending on its strategic competences [12].

Competitive advantage is commonly defined as a position attained by a business unit and perceived by its customers when it is compared with its competitors. They may be characterized as lower cost or differentiation [11]. Focus, which selects one or more segments of the company's advantage and tries to develop competitive advantages, such as A SCADA system.

Now SCADA system applies in telecom stations and mobile stations in Taiwan, the management and operation method can be proposed as follows: (1) Centralize management (2) Disperse management (3) Hierarchical management.

A SCADA system hierarchical management framework include: Central Processor (CP), Terminal Processor (TP), Monitor And Controller (MAC), Sensors and Transducer, such as: figure 2.1 and figure 2.2.

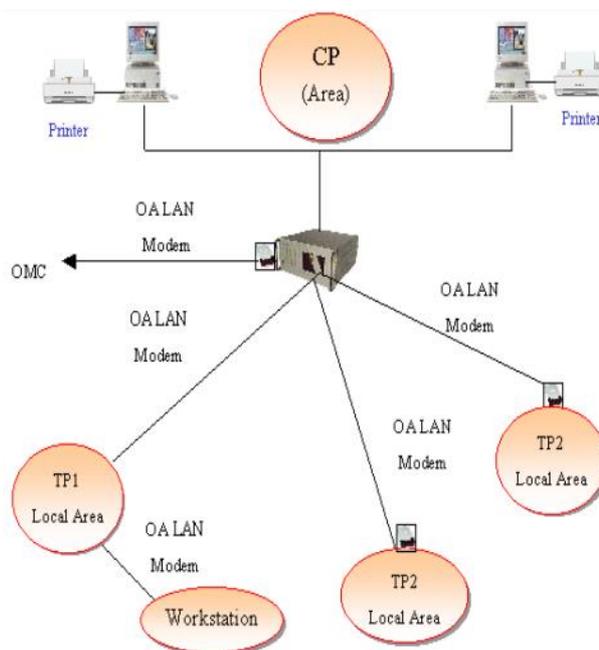


Figure 2.1 The CP Management Framework in SCADA System

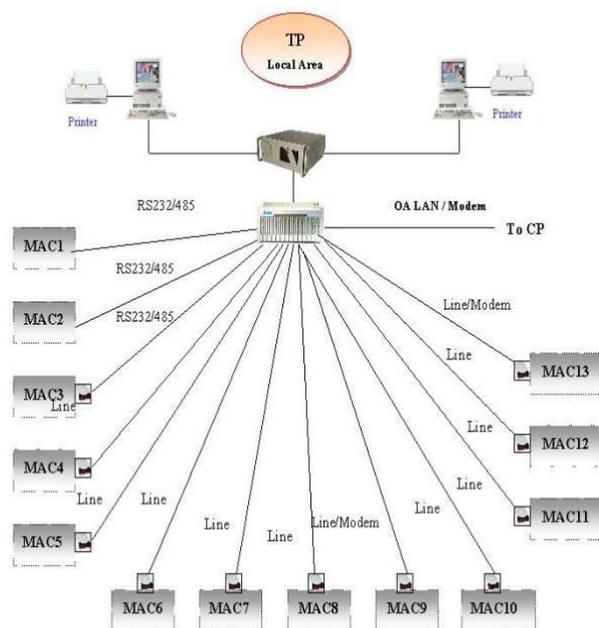


Figure 2.2 The TP Management Framework in SCADA System

### 2.2 The Equipment of Monitor and Control in Telecom Station

Monitor And Controller (MAC) provides the interface of monitor and control in mobile station (see figure 2.3) [13][14].

Alarm items include as follows:

- (a) AC source -- AC current / AC voltage detect
- (b) DC equipment -- DC equipment alarm / DC voltage output

- (c) Air condition -- Air condition operating status and Temperature
  - (d) Control Entrance -- Control Entrance detect / Alarm detect
- Control item include as follows:
- (a) Air condition control -- Air condition operation / Fan / ON-OFF.
  - (b) DC equipment -- DC equipment alarm / DC voltage output.
  - (c) BTS Remote Reset / HDLC Modem Loop-Back Test

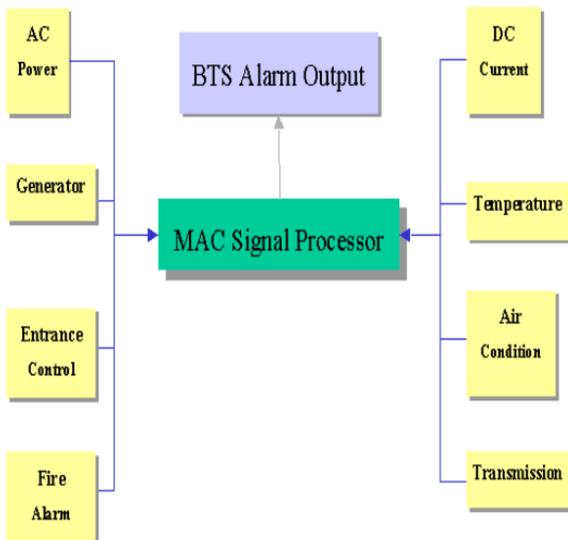


Figure 2.3 The MAC on Monitor and control equipment in SCADA System

### 2.3 Dialup Modem Application in BS Transmission Network Frame

Dialup Modem application in Basic Station (BS) transmission network. The function include as follows: [13][15][16]

- (1) The messages of equipment alarm upload to Base Transceiver Station (BTS) and MAC
- (2) Alarm messages through BTS to operator management center (OMC)
- (3) OMC through Alarm message to TP
- (4) TP use Dial-up method to control MAC and BS
- (5) TP use Dial-up method to collect history data period time.

### 2.4 GPRS Application in BS Transmission Network

General Packet Radio Service (GPRS) application in Basic Station (BS) transmission network. The function include as follows: [13][15][16]

- (1) The equipment's alarm upload to BTS and MAC
- (2) Alarm message through BTS to operator

- management center (OMC)
- (3) MAC received alarm message through GPRS to TP
- (4) TP use GPRS method to control MAC and BS
- (5) TP use GPRS method to collect history data during period time.

## 3. The Affecting Factors on Management Effective in SCADA System

### 3.1 Foreword

The basic function of SCADA in telecom station and mobile station as follows:

- (1) Alarm Real-Time upload -- (a) As alarm take place information OMC immediately (b) System with Real-Time monitor function.
- (2) Operating condition inquire -- (a) Operator can inquire equipment condition any time (b) OMC can monitor and control remote telecom station / mobile station operating condition any time.
- (3) Auxiliary function -- (a) Run basic control instructions (such as remote control) (b) According special demand to run control instructions, such as Reset (c) Remote fault remove and reduce maintenance cost
- (4) History Database -- (a) equipment and management optimization (b) equipment operating record (c) Faults and alarms statistics analysis.

### 3.2 The Analysis on Factors of Management SCADA System

After evaluating the above-mentioned information related to the SCADA system. Using Delphi method, the author has taken the items of table 3.1 to interview experts, workers and managers of telecom industry and recheck it. The content of the scale is based on a three-round Delphi survey of 10 experts. Finally, the author had concluded the effective measures that are divided into four management dimensions. There are equipment, training, personal and maintenance as bellows:

Table 3.1 The Analysis on Factors of Management SCADA System

Management Dimensions	Factors
Equipments	Network stability and Dual route
	Micro computer Base redundant The stability of MAC, Sensors and Transducer
Training	Ignore cultivation plan of worker's skills Accumulation of working experiences cannot really cultivate worker's skills

	Lack of cultivation organization of skill
Personal	Manager's concept neglect worker's skill
	Education and training is ignore
	Worker's concept with effective ideal
Maintenance	Understand software parameter and function
	Operating procedure standardization
	Use software with familiarity
	The speed on alarm of responds and inquire

### 3.3 To Draft Management Strategy in SCADA System

This section describes the information collection and system management options for the telecom industry and then the decision of management strategy in SCADA system (see table 3.2).

Table 3.2 The Analysis of Management Strategy in SCADA System

Problems	Method/Strategy
Monitor and control system stability	Draft to keep the system stability methods
Technical personnel education and training in SCADA maintenance	Technical personnel education and training
	Training on Training Institute
	Training on work
Lack of full authority by occupation, coordination and integration	There is a consensus of reducing human costs and attaching importance to worker's skills
Software parameter and function operation	Parameter setup by technical and set standard value as reference
Management and operating procedure standardization	Alarm processing procedure standardization and statistics data reports standardization

## 4. Measure the Effective on Management and Maintenance Network

### 4.1 The Analysis of Management and Maintenance Network

The section 3 has several factors analysis of management SCADA system. This paper will study and analyze the rate policy of mobile industry and also this section will discuss the effective on management and maintenance framework in SCADA system (see table 4.1). The competitive priority of cost is frequently considered either as a cost reduction or operational excellence strategy. The cost reduction or operational excellence

strategy implies a systematic improvement of company operations without the accomplishment of radical innovations.

Table 4.1 The Effective Comparison of Three Framework of Transmission in SCADA System

Framework Item	Modem / Line	E1 Time Slot Sharing	BTS Node Input Modem Dial-up	BTS Node Input GPRS
Network stability	Medium	High	Medium	Medium
Modem (quantity)	N*2	N*2	N+1	N+1
Transmission equipment cost	Medium	High	Low	High
Line/ Network Maintenance cost	High	Low	Low	Low
Response time of alarm	About 5 sec	About 5 sec	About 5 sec	About 7 sec
Speed of inquire and remote control	About 5 sec	About 5 sec	30-60秒	About 7 sec
Real-Time monitor capability	Yes	Yes	No	No
System development difficulty	Medium	Medium	Low	High
Overall investment cost	High	High	Medium	High

### 4.2 Measure the Benefit on Operation and Management in SCADA System

A SCADA system, which would provide telecom industry with guidance on:

1. The suitability of using specific competitive strategies in business environments exhibiting particular environmental characteristics;
2. The competencies required to support specific competitive strategies effectively;

3. The ability of the company to compete effectively in a number of future business environments.

Adam and Swamidass (1989) assert that “the core content of a manufacturing strategy include cost, quality, flexibility, and technology” [17,p.182].

•Costs

Costs, which means seeking a lower manufacturing cost. The customer expressed willingness in the SCADA system, but the installation of automatic monitor and controller need extra operation cost which therefore reduce the participation willingness from the customer. From the long-term viewpoint, this load management strategy will save electricity cost for the customer. After the explanation, the customer can accept the concept and will proceed to implement this alternative.

With the rapid growth of air conditioner load, the peak loading of customer in summer daytime period increases dramatically and the condition of peak loading in 15-minute leading demand contract becomes more serious. According to the electric price system in TPC, customers are asked to pay extra cost with respect to the portion of basic fee in the case that the peak loading is higher than the demand contract. On the other hand the inappropriate higher demand contract setting can avoid the occurrence of previous stated problem but will results another problem of higher basic electric fee payment. The basic idea of optimal demand contract strategy is to derive a better demand contract such that the annual electric basic cost can be minimized.

•Quality

Quality, which means implies offering high quality products and services to the customers.

1. Real-time analysis & reporting
2. Providing comprehensive reports
3. Software are easily operated and well documented.
4. Options of network connection to other systems requiring our data are provided.

•Flexibility

Flexibility, mainly related to the innovation of products and services, product mix and production volume. A SCADA system need include: operational flexibility, control flexibility, function flexibility and information system flexibility, etc.,

1. Operator can inquire equipment condition any time.
2. Operator can monitor and control remote telecom station / mobile station operating condition any time.
3. For power monitoring, electroplating process, air conditioning equipments, burn-in room monitoring etc;
4. The Windows-based system can be used to monitor equipment performance and productivity, to diagnose system problems, and to assist maintenance personnel in monitoring alarms.

•Technology

The control method of load consumption is another

way to reduce electric cost. The load consumption in automatic control can prevent the customer from penalty of exceeding contract capacity. It means when the power consumption climbs up to the climax, this method can get rid of unimportant load or the interruptible electricity equipment.

The rate, which Taiwan Power Company charges to the industrial customer, is the total power consumption in each month, i.e. how much is one kilowatt-hour? In addition, the added rate is defined as “how much is the power consumption climax in one month.” The load control device of power consumption aims to prevent the occurrence of new climax with the hope of reducing the added rate.

Owing to the deviation factor, all electricity equipment doesn’t operate at the same time. Besides the power consumption is in the status of dynamic variation due to the reasons of the boom-and-bust, season or production and sale plan. The customer has to carry out the control management of load consumption, if the purpose of the economical use on the electricity equipment is required. The monthly power consumption can be reviewed at any time to decrease the electricity cost.

## 5. Conclusions and Suggestions

### 5.1 Conclusions

1. Results indicated that the SCADA system has been highly willing to mobile and telecom industry in the development of power supply quality and to drop the operation and management cost. Also this research aims at exploring the benefit on SCADA system applications in mobile stations and to provide decision-makers and leaders with useful operation and management strategies as reference.
2. It is hoped that the conclusion of this research will be adopted by the telecom industry to implement SCADA system decrease rate expenditure and to reduce human cost.
3. The mobile industry is also willing to install the automatic SCADA system, although initial investment need extra cost.

### 5.2 Suggestions

1. The author suggests that the further research shall focus on the equipment characteristics and the management characteristics of other industry with mass and disperse power equipment. It is also desired that a feasible useful management strategy is developed to assist the other industry customer to reduce operation and management cost and to increase the competitive capability.
2. The final suggestion is that the future research shall

focus on the analysis of power consumption characteristics for the various industries with large power consumption.

## References

- [1] "Demand-side Management Vol.2, Evaluation of Alternatives", Prepared by Edison Electric Institute, EPRI Final Report, August 1984, EA/EM-3597.
- [2] "Standards for preparing reports of the load research committee", Association of Edison Illuminating Companies, 1980.
- [3] "Load research manual/Load Research committee", 1990 Association of Edison Illuminating Companies, Printed in the United States of America policy.
- [4] "Supervisor Control and Data Acquisition System Maintenance Book", Control-Net International INC, 2000.
- [5] The Economist (1995), "Telecommunications: the death of distance", 30 September.
- [6] Asian Wall Street Journal (1998), "Asian telecommunications", 2 June.
- [7] The Economist (1997), "Managing telecoms. Old champions, new contenders", 11 October.
- [8] The Economist (1998b), "Surviving the telecoms jungle", 4 April.
- [9] The Economist (1998a), "The end of privatization?", 13 June.
- [10] Bank of America (1996), Guide to Telecommunication in Asia, Euromoney Publications, Hong Kong, pp. 1-6.
- [11] Porter, M. (1980), Competitive Strategy, Techniques for Analysis Industries and Competitors, Free Press, New York, NY.
- [12] Abell, D.F. (1979), "Defining the business", Prentice-Hall, New York, NY.
- [13] Journal of Chunghwa Telecommunication Co., Ltd. Vol. 5, No.5, October 1991.
- [14] Nortel Technical power Seminar, 1997
- [15] "Mobile Message", Chunghwa Telecommunication Co., Ltd. Mobile Business Branch, Aug 2001.
- [16] Journal of Chunghwa Telecommunication Co., Ltd. Vol. 5, No.5, October 1991
- [17] Adam, E.E. and Swamidass, P.M. (1989), "Assessing operations management from a strategic perspective", Journal of management, Vol.15 No.2, pp181-203.

# Adaptive Streaming in Mobile Network

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## Abstract

Mobile e-commerce is immersed rapid familiar to other high-flying Internet markets. With the fast developing of wireless connections and Internet, electronic commerce more and more moves to mobile environment. Streaming, as a rapid growing application in Internet, will be more used in mobile e-commerce. In this paper, we'll review the network protocol used in mobile e-commerce and streaming technology. An optimized architecture is given based on MPEG-4 and Mobile IPv6. The core streaming protocol used in this architecture is RTSP/RTP proposed by IETF. This system gives one possible implementation of streaming over wireless network. Two key bottlenecks we found in this project are wireless bandwidth and mobile client power. To avoid the two problems, self-adaptive methodology is used. Let streaming application be adaptive to the wireless network environment to improve streaming performance.

## 1. Introduction

With the fast growing of wireless connections and Internet, mobile e-commerce is immersed as other high-flying applications. Enterprises are incorporating mobile commerce into their operation as a way to cut costs, generate revenue and gain efficiencies. Consumers are also like to accept multimedia content while not static ones. Applications will be developed for the mobile e-commerce and enable enterprises and consumers communicate efficiently. Of course, these applications and new mobile e-commerce solutions will drive the growth of mobile e-commerce.

Streaming as another fast growing application in Internet catch more and more users' attention. With the emergence of webcasting, users enter into a new world of digital content. Wireless communication gains the huge success and will be integrated into Internet. While wireless network is different from wired network, streaming over wireless network is challenging. In wireless network, bandwidth is low, latency is large and mobile handset is not powerful. All these characters are critical to move streaming over wireless network. To solve these problems, we use self-adaptive methodology to let the upper layer applications to be adaptive to the lower network environment. Wireless network is not stable. Bandwidth and latency is always changing. To make streaming be adaptive to the wireless network is a possible solution. When wireless network performance decreases, change

the streaming bit rate to a lower value that the wireless network can provide. Then users can receive smooth stream in mobile environment. It's critical to mobile e-commerce.

This paper is organized as following. Section II will review the protocols used in mobile network. In section III, streaming technology is discussed. Streaming over mobile network architecture is defined in section IV. Future work is discussed in section V. Section VI gives our conclusion.

## 2. Protocols in Mobile Network

IP (Internet Protocol) is designed for wired network. How to use it over wireless network is challenging. Mobile IP [1] and Mobile IPv6 is the network layer protocol standard proposed by IETF to supporting roaming between different networks.

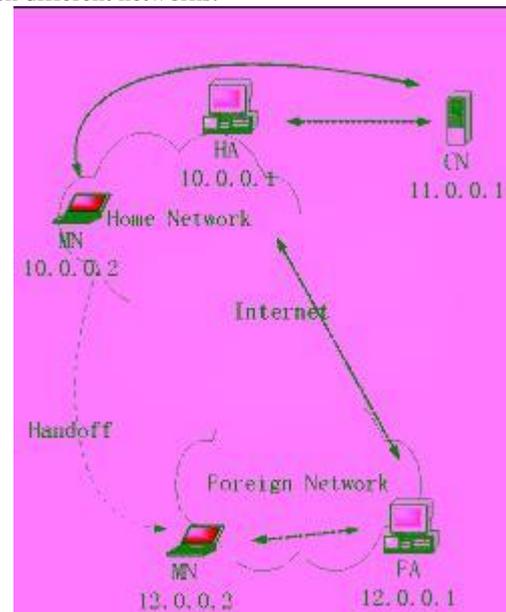


Figure 1. Mobile IPv4

In wired network, when node is connected to an IP network, it has a static IP address that identifies itself and one default router to communicate with foreign network. However, mobile device will connect to different network and will use different IP address and router. For example, a laptop computer may be connected via an Ethernet card at home. At office, it's connected via wireless LAN. When on bus, it goes online through a GSM connection. Different connection media supports different service. Also only one IP address without Mobile IP is not possible. User

needs to change the IP address when changing connection. But changing IP address will make upper layer application not work. Mobile IP and Mobile IPv6 are Internet standard to provide mobility in network layer. To upper layer, IP address is not changing with Mobile IP/IPv6. So they provide transparency to upper layer.

In Mobile IP and Mobile IPv6 protocol, the main problem is how to maintain one IP address while in different network. They use HA(Home Agent) to provide transparency for upper layer. When MN(Mobile Node) is at home network, it uses its own home address as normal IP. While MN moves to foreign network, all the packets between MN and CN(correspondent Node) are relayed by HA. So CN will not be care about where MN is, since it only needs to know MN's home address. MN at foreign network will use its COA(Care-Of Address) to communicate with home agent. The main idea in Mobile IP is using agent to provide transparency. One problem here is that triangle routing exists. It will decrease transmission performance. So in Mobile IPv6, Binding Cache is used to avoid it. There is a binding cache in CN and HA, which is maintain a map between MN's home address and care-of address. Then, when MN moves to foreign network, it will send binding update to CN and HA. CN will communicate with MN using this care-of address while not through HA. Triangle routing problem is avoided.

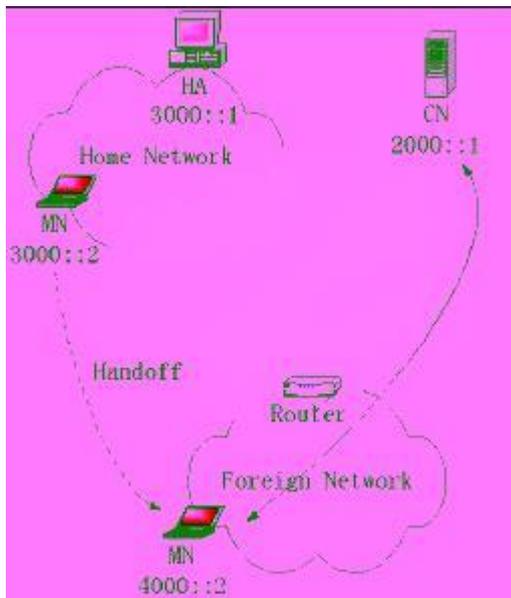


Figure 2. Mobile IPv6

Handoff time interval is important to users, since real-time applications cannot be tolerant to large delay time. There're two handoff mechanisms, Network Initiated Handover and Mobile Initiated Handover. In network initiated handover, the router has predictive information about the new point of attachment to which the MN will move prior to the actual movement of the Layer 2 connection. The router initiates signaling to the MN and HA to start the Layer 3 handover. In mobile initiated handover, the MN has predictive information about the

new point of attachment to which it will move, or it chooses to force movement to a new point of attachment. The MN initiates signaling to the router to start the handover.

### 3. Streaming Technology

Streaming is the ability to distribute "continuous" digital content over networks in real time. Digital content can be streamed to any network device. Different network has different performance. That performance will determine the streaming quality. Below, some figures are listed.

Streaming Media Capabilities by Bandwidth

Connection	Bandwidth
Modem	28.8-56Kbit
ISDN/Frame Relay	64-128Kbit
Cable Modem/DSL	100Kbit-1Mbit
WLAN	1Mbit-10Mbit
Corporate Networks	1Mbit+

Table 1. Connections and Bandwidth

Streaming Transfer Rates

Medium	Transfer Rate
Audio	Under 22Kbps
Typical 2001 Internet streaming	56Kbps to 300Kbps
VCR/TV quality	1-2 Mbps
HDTV quality	6-9 Mbps and eventually higher for MPEG-4

Table 2. Streaming Transfer Rates

Some market trends will influence the streaming technique and its application according to [6] [7].

- 1 Advances in encoder and production techniques
- 1 Proliferation of broadband access to consumer and enterprise users
- 1 Increased number of powerful PCs capable of playing rich streaming media
- 1 Web site differentiation for broadband users

#### 3.1 MPEG-4

MPEG-4 is the most recent multimedia standard developed by Joint Technical Committee ISO/IEC JTC 1, Information Technology. MPEG-4 standard implies that motion video can be manipulated to a form of computer data and can be stored on various storage media transmitted and received over existing and future networks and distributed on existing and future broadcast channels. MPEG-4 provides features that include Scalability, Shape coding, Error resilience, Face animation, etc.

Below is some key features of MPEG-4 System:

- 1) MPEG-4 Systems provides a consistent and complete architecture for the coded representation of the desired combination of streamed elementary audio-visual information. This framework has a broad range of applications, functionality and bit rates. Through profile and level definitions, MPEG-4 Systems establishes a framework that allows consistent progression from simple applications (e.g., an audio broadcast application with graphics) to more complex ones (e.g., a virtual reality home theater).
- 1) MPEG-4 Systems augments this architecture with a set of tools for the representation of the multimedia content, viz., a framework for object description (the OD framework), a binary language for the representation of multimedia interactive 2D and 3D scene description (BIFS), a framework for monitoring and synchronizing elementary data stream (the SDM and the SyncLayer), and programmable extensions to access and monitor MPEG-4 content (MPEG-J).
- 1) MPEG-4 Systems completes this set of tools by defining an efficient mapping of the MPEG-4 content on existing delivery infrastructures. This mapping is supported by the following additional tools: an efficient and simple multiplexing tool to optimize the carriage of MPEG-4 data (FlexMux), extensions allowing the carriage of MPEG-4 content on MPEG-2 and IP systems, and a flexible file format for authoring, streaming and exchanging MPEG-4 data.

## 4. Optimized Streaming over Mobile IPv6

### 4.1 Features of Mobile IPv6

Handoff time

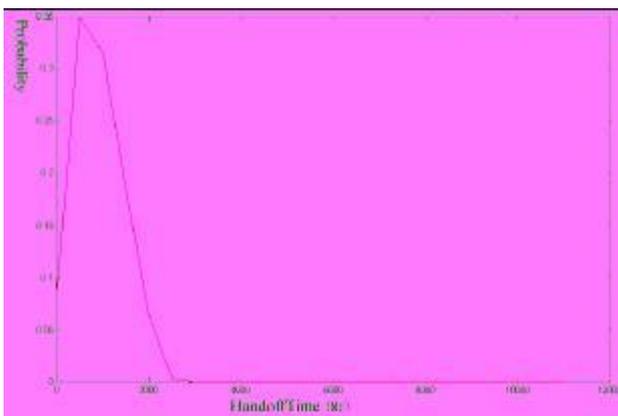


Figure 3. Mobile IPv6 Handoff Time

Below, a typical handoff time is given in Figure 3. We can see that the average handoff time in mobile ipv6 is 1.5m. The handoff time will directly influence the streaming performance. In the handoff interval, the streaming packets

will be dropped. So the faster the handoff, the better the performance when handoff.

### 4.2 Objectives

This implementation is to enhance streaming transmission in mobile network. Wireless or mobile network is challenging to multimedia applications. It's different from wired network. Some characters of wireless network: 1) Error prone network; 2) Slow handoff; 3) Packet transmission are critical to upper layer applications. While multimedia applications require more bandwidth and even rate, some challenges stay here. This project is to enhance streaming quality when handoff in mobile network.

### 4.2 Methodology

To enhance streaming quality when handoff, more function should be added in network layer and upper layer. In network layer, we modify mipv6 to add an interface. This interface is to provide previous and current network performance to upper layer. Latency and bandwidth are concerned. In the upper layer, we modify RTSP protocol to adapt streaming transmission to the current environment.

Assume one Mobile Node was playing movie from Correspondent Node source. The Mobile Node switched from one network to another network and handoff occurred. The environment changed including bandwidth and latency. Assume the previous network bandwidth is 100k and the current is 60k. If the streaming rate is 90kbps, the current bandwidth clearly can not afford the streaming. Then packet dropping will be serious. So we need a mechanism to deal with it. In our implementation, when handoff, the network layer (mipv6) told upper layer the round bandwidth. The upper layer (RTSP) will decide how to deal with it. Of one condition, RTSP will request low rate steam to be adapted to the low bandwidth. Of other condition, RTSP will request high rate stream to improve the media quality since the bandwidth is enough after handoff.

In this project, Mobile IPv6 support in linux ([www.mipl.mediapoli.com](http://www.mipl.mediapoli.com)) is used to provide mobility in network layer. Streaming server uses Darwin Streaming Server ([www.apple.com](http://www.apple.com)) and client uses MPEG4IP ([www.sourceforge.net/project/mpeg4ip](http://www.sourceforge.net/project/mpeg4ip)). MPEG4 stream is used to test streaming.

Other relative projects and methods such as [2] [3] [4] [5] focus on improvement in network layer. They provide mobility and are transparent to upper layer, which is different from our method. Since the network performance is critical to streaming, we provide network feature to upper layer.

### 4.3 Challenge

- 1) We choose Darwin Streaming Server (DSS4) as it's open source and supporting mpeg4. Port DSS4 to ipv6.
- 2) Add a function in Mobile IPv6 protocol stack to

provide network bandwidth and latency to upper layer. It's difficult to test bandwidth. Round bandwidth is given here.

3) Support more SDES items used to change streaming rate.

4) Application console to let the user decide what to do when handoff.

#### 4.4 Implementation

In the network layer, we add an module to detect network performance. Its function is to detect the current network bandwidth and latency and provide them to upper layer. In application layer, we use User Control Panel to get user's decision. The decision will directly influence the transport layer and represent layer.

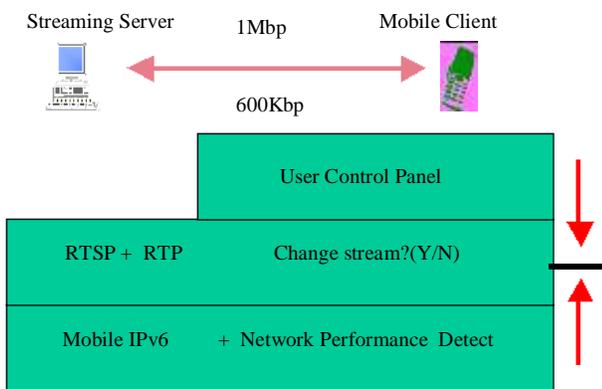


Figure 4. Architecture

Let's see the process in mobile network. When MN is in home network, the bandwidth it could use is 1Mbps, which is provided by the NPD (Network Performance Detect module). When MN is switched to foreign network, NPD module will detect the handoff and provide the new network performance to the upper layer. Assume the bandwidth in foreign network is 600kbps. Sure, if MN is playing video in 800kbps, the handoff will cause so much packet dropping. The video quality will remain poor in the foreign network. In our architecture, the User Control Panel will capture the handoff event and get the network performance from the NPD module. There're two strategies here. Let user decide or let MN auto configure. Each strategy is an decision to be adaptive to the current network performance. In this example, just let user decide how to do with the handoff. It could be using low bit rate streaming to get fluent video or just going back to the older network.

## 5. Future Work

About future work, we'll focus on the module of Network Performance Detection. How to detect the network performance while consuming little network resource is important to the architecture. If possible, prediction of the new network will improve the system performance very much. Another important task is to research the strategy. It's more close to user. We should make a tradeoff about it.

## 6. Conclusion

This paper provides a possible solution to how to improve streaming quality in mobility environment. we use self-adaptive methodology to let the upper layer applications to be adaptive to the lower network environment. In the network layer, we add an module to detect network performance. Its function is to detect the current network bandwidth and latency and provide them to upper layer. In application layer, we use User Control Panel to get user's decision, which will influence the transport layer and represent layer. An implementation is given.

## References

- [1] C. E. Perkins. *IP Mobility Support*. Network Working Group, Request for Comments 2002, October 1996.
- [2] C. E. Perkins, K-Y. Wang. *Optimized Smooth Handoffs in Mobile IP*. Proceedings, IEEE International Symposium on, 1999.
- [3] H. Soliman, C. Castelluccia, K. El-malki, L. bellier. *Hierarchical MIPv6 mobility management*. IETF draft-ietf-mobileIP-hmIPv6-02.txt, February, 2001.
- [4] H. Balakrishnan, S. Seshan, and R. H. Katz. *Improving Reliable Transport and Handoff Performance in Cellular Wireless Networks*. ACM Wireless Networks, 1(4), December 1995.
- [5] R. Caceres and V. N. Padmanabhan. *Fast and Scalable Handoffs for Wireless Internetworks*. In The Second Annual International Conference on Mobile Computing and Networking, pages 56-66, Rye, New York, November 1996. ACM and IEEE.
- [6] *Streaming Media Workflow: An Overview*, Sun Microsystems, July 2002.
- [7] *Building a Streaming Delivery Network*, Vividon, October 2001.

# Building an End-To-End Security Infrastructure for Web-Based Aerospace Components E-Trading

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## Abstract

The research paper focuses on the development of a generic framework and architecture for building an integrated end-to-end security infrastructure and closed-loop solution to secure e-commerce and m-commerce. As an integral component, an intelligent decision support mechanism is developed in helping systems designers and managers make architectural, design, implementation, and deployment decisions on employing particular security solutions to issues and requirements arising in various e-commerce and m-commerce scenarios. In addition, this research identifies the key features, options and benefits of several security technologies as well as provide guidelines in managing the costs and complexities involved in the deployment of those security solutions. As an important groundwork for building a prototype based on the proposed research work, a study has been conducted to investigate the current B2B e-commerce operations between Pratt & Whitney (P&W) [15] (a division of United Technologies Corporation (UTC) [17]) and its partnering e-business and supply chain players in the aviation industry.

## 1. Research Objectives

Addressing the essential security issues and needs in e-commerce and m-commerce, an integrated and scalable security infrastructure is crucial to enable a company to reap substantial business values and financial benefits by safeguarding online transactions according to the policies, processes and procedures unique to its business.

As a significant research result, the proposed common framework will help a company achieve its security objectives in different dimensions as follows:

- 1) Construct an integrated, flexible and scalable security infrastructure that tightly fits in with other corporate e-business, supply chain management, customer relationship management, and enterprise resource planning

(ERP) applications as well as with those of its customer and business partners.

- 2) Develop a security architecture with segmental entities (computers, local networks, private networks, public networks, etc.) to help isolate and identify the security issues, possible attacks, data vulnerability, and associated security requirements and in turn find attainable solutions to address specific requirements (specified assurance levels, security services, etc.) for each entity in various B2B interaction scenarios.
- 3) Reduce the chance of a security breakage by removing security issues from the application level and raising them to an architectural level.
- 4) Provide proactive and reactive security strategies, policies and guidelines.
- 5) Provide decision support capability [16] for selecting security tools and technologies as well as managing the costs and complexities involved in the technology deployment.

## 2. Background of E-Commerce Security in Aerospace Industry

B2B e-commerce for online trading of aerospace and aviation components is still in its infancy [9]. The potential of using the Web as a B2B commercial medium has been widely explored. However, a critical assessment of its B2B e-commerce challenges and issues has just started to receive attention. The new economy of ubiquitous B2B e-commerce usually introduces new risks [7], [8].

Based on the initial study, P&W's customers and suppliers can process online transactions through either private corporation e-business channels or via semi-private web-enabled exchanges (e.g., Cordiem [12] and Exostar [13]). E-business transactions in a B2B environment can happen in the context of a bilateral or multilateral exchange. Such a virtual marketing environment gives unprecedented open participation of business trading and information sharing. As submerging

under the uncharted waters, each type of exchange may raise significant issues and concerns threatening the objective of establishing a secure trading environment between P&W and its e-business counterparts (customers, suppliers, and other business partners). Without proper security measures and strategies, it will make e-marketplaces susceptible to such incidents as denial of service (DoS) attacks (which will halt on-line operations [10]), 'bid snatching' (wherein a set of malicious colluding agents halt another agent by using attractive bids to fraudulently 'snatch' and non-perform on all the targets' subcontracts), 'bid collision loops' (where a pair of agents halt online B2B transactions by establishing an infinite loop of colliding bids), and so on. This project effort specifically tackles one of the threads to this resource availability, the denial of service (DoS) attack [7], and suggests a viable solution to preventing possible loss of business due to the fact that P&W's data are made impossible to access by the legitimate customers or suppliers.

Electronic markets (e-markets) also give unprecedented scope to the deployment of relatively untested marketing and bidding mechanisms whose vulnerabilities have not been fully explored [18]. The consequences may thus bring forth the potential for serious disruptions in B2B operations of targeted business trading participants and/or the e-markets themselves.

### 3. E-Business Security Requirements

Addressing the potential risks and pressing issues of on-line B2B trading, this research project tackles a number of challenges in various e-commerce scenarios, such as client authentication, server authentication, authorization, etc. Proper access control is important. In other words, the company needs to know that the customers or suppliers who involve in a B2B dialogue are in fact who they claim they are, which can be referred to as "client authentication." On the other hand, when the customers or suppliers access a web site in the B2B e-marketplace, they want to make sure that they are indeed interacting with that site and not with an impostor. This is referred to as "server authentication." It is also necessary to control what information which business partners are allowed to access and/or modify. In addition, a reliable access for external players to gain access to a company's e-business ballpark and interact with the specified data is one of the critical requirements – all the legitimate B2B players should be able to access the required resources at any time under optimal performance.

Electronic data traveling on a complete supply chain and B2B environment requires more than access control. Authorization is recognized as another important

security criteria and recognized as a problem with greater complexity than authentication and access control. The user privileges of the corporate customers and suppliers should be manageable and interchangeable across enterprise applications as well as other B2B communities of security domains. Furthermore, it is required that pertinent business rules and constraints should be dynamically weighed up coupling with fine-grained role privileges for initiating and committing required business transactions and processes.

"Integration" is a key to the proposed common framework for ensuring that all the security decisions (on authorization, authentication, auditing, etc.) that implement on each enterprise application and exchange point are consistent with those made across the entire B2B arena. The security infrastructure should be pervasive across the entire enterprise to establish greater communities of trust. As more and more business partners exchange trading information via various network connections (a private network, Internet, etc.), different security control services and standards are indispensable. The proposed security infrastructure is open in nature to ensure sound security interoperability – the capability of supporting heterogeneous security standards and platforms as well as different e-business interaction models and security services.

### 4. Research Methods

An engineering and scientific approach [11] is adopted to the research tasks undertaken in this project.

Primarily, the following methods [1], [2], [3], [5] are used to validate the proposed framework:

- 1) Conceptual Design. To construct a conceptual security framework and an integrated, flexible and scalable security architecture that tightly fits in with P&W's enterprise resource planning applications as well as with those of its customer and business partners.
- 2) Security Solutions Evaluation. To evaluate a number of state-of-the-art security solutions and technologies (such as Entrust's Privilege Management Infrastructure integrated with XMI, ebXML, and Security Assertions Markup Language) and elaborate how the solutions fit into the entire security framework.
- 3) Cases and Best Practices Study [4], [6].
- 4) Scenario-Building. To develop a series of scenarios to test the security requirements of different segmental entities (computers, local networks, private networks, public networks, etc.) to help isolate and identify the security issues, possible attacks, data vulnerability, and associated security requirements and, in turn,

find attainable solutions to address specific requirements (specified assurance levels, security services, etc.) for each entity in various B2B interaction scenarios (Figures 1 and 2).

- 5) Laboratory Experimentation [14] and Simulation. To create an artificial environment, in order to isolate and control for potentially confounding variables; to conduct the study of a simplified, formal model of a complex e-commerce environment, in order to perform experimentation not possible in a real-world setting.

## 5. Research Results

Key outcomes of this research effort as well as major benefits from deploying the proposed framework are summarized in the following paragraphs:

### 5.1 An Integrated Security Framework

The developed framework is used to examine the explosion in B2B e-commercial activity on the Web especially for a company and its business trading partners. The framework provides a viable decision support mechanism in making architectural, design, implementation, and deployment decisions on employing particular security and connectivity solutions to issues and requirements arising in various B2B e-commerce scenarios.

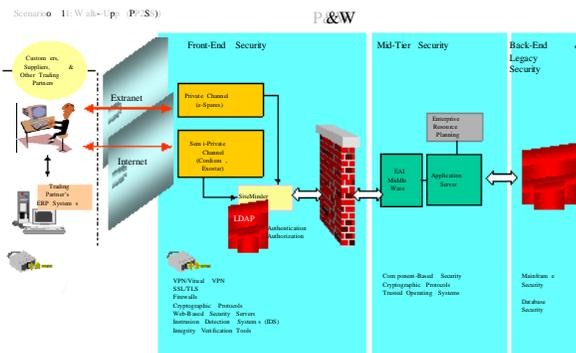


Figure 1. Aviation B2B E-Commerce Security Architecture: Transactional Scenario 1: Person/Human-to-Systems (P2S) Interaction.

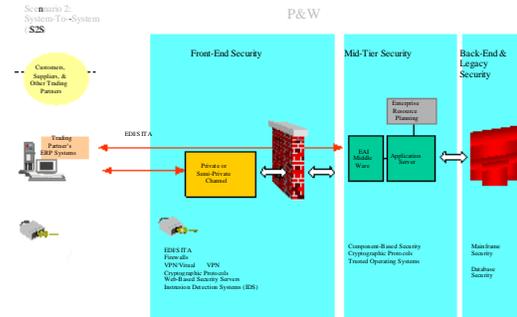


Figure 2. Aviation B2B E-Commerce Security Architecture: Transactional Scenario 2: Systems-to-Systems (S2S) Interaction.

### 5.2 A Decision Support System for Web Security Analysis

Security involves a total set of exposures in B2B e-commerce. Besides storing on computers, transactional data need to travel from within the perimeter of company's network (Intranet) to the space of its suppliers' and business partners' enterprise applications through Extranet or Internet as well as to voyage to the terrain of its customers via Internet. As a result, it is unattainable to maintain a robust security control by simply implementing an "one-size-fits-all" solution. Data traveling between diverse communication dimensions need to be secured differently. For instance, each of the communication points may have its own authentication and authorization policies and schemes. Accordingly, a decision support Expert System (ES) is to be developed to aid the corporate security analysts in finding a fitting security solution and configuring proper settings at each of the network points throughout the entire B2B chain. In the research, the security requirements are identified and categorized based on different needs on the two sides of an e-marketplace:

**The Seller Side.** The selling parties in the B2B e-marketplace are mostly interested in the identification and authentication of users (buyers). The sellers are concerned with acquiring adequate buyers' data and installing robust security measures for billing and other business transactional purposes, such as preventing the sender of a message from denying having sent it and mitigating the risks of so called Denial-of-Service attacks.

**The Buyer Side.** The participants on the buyer side in the e-Marketplace share a common interest in the

integrity and confidentiality of the information transmitted. Usually, buyers are more interested in reliable services and expect their privacy to be soundly protected. In most of the cases, they may prefer to use services without being identified and being monitored of their every single movement on the Web by the unrelated business parties.

Consequently, the first phase in the decision support ES construction focuses on the six essential security requirements shown as in Table 1.

Table 1. Security Requirements on Buyer’s and Seller’s Sides

	Security Category Code	Requirement	Description
Seller Side	A1	Authentication	Verifying that the trading partners are really who they claim they are. A process is necessary to proof the two parties involved in a B2B interaction are given a guarantee that they are indeed interacting with whom they think they are interacting.
	A2	Authorization	Ensuring that each business party is performing what it is authorized to do.
	A3	Availability	Tacking the Denial of Service (DoS) attacks .
	NR	Non-Repudiation	Preventing the sender of a message from denying having sent it.

Buyer Side	C	Confidentiality	Protecting the contents of messages or data transmitted over the Internet from unauthorized people.
	DI	Data Integrity	Shielding sensitive trading information from being modified or tampered by an attacker.

Based on specific security needs and scenarios, the decision support ES (with the code name, AirB2B SecurityGuru) will be assisting in finding corresponding security solutions. For instance, a viable authentication technology will be recommended to tackle A1 requirement while a proper authorization solution and an encryption solution is suggested to address the access control and the tampering issues, respectively. Furthermore, the user is allowed to enter English-like questions on any specific security problems via natural language processing.

As a powerful tool, the ES can give consultations in the following areas:

- Identify assets and vulnerabilities to known threats
- Identify likely attack methods, tools, and techniques
- Establish proactive and reactive strategies
- Develop an incident response plan
  - Developing incident handling guidelines.
  - Identifying software tools for responding to incidents/events.

### 5.3 Security Solution Matrices

One of important deliverables of this research effort is to construct a pertinent security solution matrix for providing information and assessment on various feasible solutions to security needs (at both the company side and trading partner’s side) based on a given scenario.

### 5.4 A Security and Performance Analysis Model

Security is an important element in B2B interactions but performance is the price to be paid to meet the desired security criteria. Therefore, it is

important to determine the adequate level of security for special e-business exchange scenarios without incurring unnecessary costs and sacrificing too much system performance. In this research, the decision of the degree of security is modeled as an optimal function of resource protection, system performance and the security-related costs (infrastructure, implementation, maintenance and processing costs, etc.)

### 5.5 A Laboratory Experimentation and Simulation Environment

A laboratory environment is built to simulate various B2B interaction scenarios (system-to-system or person-to-system). Based on the existing security countermeasures and infrastructure, the lab environment helps identify vulnerabilities in various spots in the entire e-business chain (such as Internet connections, remote access points, connections to other business partners, physical access to network hardware, and user access points) and the type of threats. Performing such simulations and experiments will assist in determining the risk levels (system-level, network-level, or organization-level) and, in turn, seeking for a set of viable solutions (including technologies and processes) to address specific security attacks and needs.

In the developed simulation environment, a number of essential B2B Actors are created to simulate how those key business trading actors interact with each other in various B2B transactions. Some of the key B2B actors identified in the first phase of this research effort are: CUSTOMERS, PARTNERS, SUPPLIERS, REGULATORS, MEDIATORS, and INTERNAL EMPLOYEES.

### 6. Conclusions

Besides the technical aspect of the B2B e-commerce discussed in this paper, an equally important organizational issue is to be dealt with to ensure a truly secured and safe e-marketplace for doing business on the Web -- trusts among business partners. To fully utilize the advantages of the open and ubiquitous technology of the Internet, trust makes it possible for extensively cooperative and collaborative endeavors among various players in the B2B e-marketplace. Trust is a key to positive interpersonal and inter-organizational relationships in various settings. Trust becomes even more central and critical to sustain everlasting business relationships, especially, when a great deal of sensitive business data are required to be shared among business partners over an Internet-based network. As a result, one of the future research efforts will be focusing on conceptualization of business trust model which should be cross-organizational in nature. Research work in other

disciplines (e.g., social science and organizational behavior) on trust will be studied and compared. Ultimately, the development of new e-business models for innovative business processes reengineering is perceived as one vital research activity for achieving to truly trusted and trusting B2B e-commerce environment.

### References

1. Alavi M. & Carlson P. (1992) 'A Review of MIS Research and Disciplinary Development' *J. Mngt Inf. Syst.* 8,4 (Spring 1992) 45-62.
2. Baskerville, R. and A. T. Wood-Harper (1998) 'Diversity in information systems action research methods' *European Journal of Information Systems* 7, 2 (1998) 90-107.
3. Benbasat I. (1984) 'An Analysis of Research Methodologies' in McFarlan (1984), 47-88.
4. Benbasat I., Goldstein D. & Mead M. (1987) 'The Case Study Research Strategy in Studies of Information Systems' *MIS Q* 11,3 (September 1987) 369-386.
5. Cash, J.I. & Lawrence, P.R. (Eds.) (1989) 'The Information Systems Research Challenge: Qualitative Research Methods' Volume 1, Harvard Business School, 1989
6. Cavaye A.L.M. (1996) 'Case Study Research: A Multi-faceted Research Approach for IS' *Information Systems J.* (1996) 227-242.
7. Clarke R. (2001) 'Introduction to Information Security', February 2001, at <http://www.anu.edu.au/people/Roger.Clarke/EC/IntroSecy.html>
8. Clarke R. (2001) 'Trust in Cyberspace: What eCommerce Doesn't Get' at <http://www.anu.edu.au/people/Roger.Clarke/EC/TrustCLE01.html>.
9. Clarke R. (1997) 'Electronic Commerce Definitions', January 1997, at <http://www.anu.edu.au/people/Roger.Clarke/EC/ECDefns.html>.
10. Clarke R. (1997) 'Data Surveillance: Theory, Practice & Policy', July 1997, at <http://www.anu.edu.au/people/Roger.Clarke/DV/ICIS97.html>.
11. Clarke R. (1996) 'Appropriate Research Methods for Electronic Commerce', June 1996, at <http://www.anu.edu.au/people/Roger.Clarke/EC/ResMeth.html>.
12. Cordiem, <http://www.cordiem.com/>
13. Exostar, <http://www.exostar.com/>
14. Jarvenpaa S.L. (1988) 'The Importance of Laboratory Experimentation in Information Systems Research' *Commun. ACM* 31, 12 (December 1988) 1502-1504.
15. Pratt & Whitney, <http://www.pratt-whitney.com/>

16. Sprague R. (1980) 'A Framework for Research on Decision Support Systems' MIS Quarterly 4, 5 (1980) 1-26.
17. United Technologies Corporation,  
<http://www.utc.com>.
18. Zwass V. (1996) 'Electronic Commerce: Structures and Issues' Int'l J. Electronic Commerce 1,1 (Fall 1996) 3-23, at  
<http://www.mhhe.com/business/mis/zwass/ecpaper.html>.

# The Study and Implementation of Network-Based Auditing System with Session Tracking and Monitoring

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## Abstract

With consideration of the increasing importance of auditing system and the present auditing systems' incapability of performing packet reassembling analysis, this research attempts to develop a "network-based auditing system with session tracking and monitoring" to assist network administrators to analyze and rearrange the packets into separate session groups. This developed system is able to reveal every single step of the unauthorized activities. As a result, the administrators can investigate each network session and its transferred data more efficiently, and reduced greatly the time for auditing data analysis. In addition, the event reconstruction simulates the actual event occurred at that time; this feature provides network administrators with more detailed and realistic insight concerning vulnerabilities in network security that need to be fixed. Also, this system keeps track of all network events, and collects related information in a set of auditing files (log files). Moreover, the collected records and reassembled files can serve as evidences in tracing cyber-crimes and as references for recovery process.

Keywords: network-based auditing system, session tracking, session reassembling, cyber-crime

## 1. Introduction

Ever since computer's birth, its popularity grows with its increasing importance. In fact, it has become an indispensable tool in today's modern society. Internet's advent creates a new medium that allows messages and data to be transmitted globally. As Internet progresses, more and more crimes are gradually extending its domain from human communities to this virtual dimension. And, network security has become a critical issue for users around the world. Nowadays, hackers vandalizing servers, violating privacy and stealing confidential information have become the new type of criminal act, which often causes victims to suffer from great damages. Hence, effective management and sound defensive facilities are crucial in ensuring network security. Techniques such as implementation of IDS and firewall have being widely applied to fortify and protect network system from intrusion. However, despite of putting in great effort in enforcing the defense measures, there is still no guaranteed security. Nevertheless, an auditing system can be installed to keep track of all system events

and collect related information in a set of auditing files. These records served as evidences and references that can be utilized later in tracing cyber-crimes. Very often, the notion of getting caught can prevent hackers from actually carrying out the illegal act. Also, by analyzing auditing files, system managers are able to discern unusual activities. Presently, many types of intrusion detection system (IDS) have been proposed; however, those auditing files are kept in binary form [1] [2] [10] [12] and requires manual work to "read out", hence it requires complicated expertise and significant amount of time. In consideration of the increasing importance of auditing system and the need of improving efficiency of analysis on auditing files, this research attempts to develop a network-based auditing system, that has the ability of session tracking and monitoring. This developed system will rearrange those auditing data recorded by network-based IDS to reconstruct and simulate the real events occurred to overcome analysis difficulties. In addition, records and reassembled files can serve as evidences in tracing cyber-crimes and as references for recovery process.

## 2. Literature Research

### 2.1 Definition of Auditing System in Information Technology

"Auditing System" is a system that keeps track of system events and examines the audit files and audit trail actively, periodically or randomly to detect any trespasses and suspicious activities. All the information system on firewall, computer and server will records detailed information about each services provided. And, the collection of all these records, storing the information concerning system events, is called an audit file or log file. By studying the information extracted from audit files, system administrators are able to discern both implicit and explicit problems. Also, solutions can be devised in accords to the given analysis result in order to prevent similar problems form affecting system operation again.

Network auditing, simply, is a mechanism that targets on tracking network-specific events. Generally speaking, these detected activities are, likewise, stored into log files for reference in the future. Through network auditing, network administrator can investigate the data traveling between servers and clients, or monitor a specific connection and event. Such mechanism is

capable of detecting and tracing any unauthorized activities, as well as potential hackers.

Therefore, administrators should examine these log files periodically. However, the analysis process is complicated and the audit files' content is difficult to understand; hence, the task is preferably to be completed with the assistance from analyzing tools.

## 2.2 Categories of Auditing System

Auditing systems can be categorized into "Host-Based" and "Network-Based", according to the source which they collect information from. Host-Based auditing system's main mission is to monitor the intrusion events from the host itself. For instance, user priority, file access and system manipulation are all monitored locally. Network-based auditing system treats each incoming and outgoing packet with different storing processes. The packet recording process and historical audit files often provide helpful information, such as debug process, system performance evaluation and evidence for illegal acts, in times of anomalies' occurrence. Network-Based auditing system captures packets stealthily; it gives no hint to the suspect in realizing the existence of this system. On the other hand, the audit files kept by Host-Based auditing system are likely to be modified by intruders intending to erase the crime evidence.

## 2.3 Present Auditing System

### 2.3.1 Host-Based Auditing System

- tripwire: tripwire is a "System File Integrity Inspection System", which finds out what are the files that have been modified. The system performance is satisfactory, and it occupies minimal space. Also, tripwire inspect the forged sessions coming from intruders. In addition, tripwire can re-adjust itself to accommodate various system configurations and provide flexible control in managing system file locations.
- Swatch: swatch is "Simple WATCHer" for short. It is the most popular host-based auditing system under Unix operating system. Swatch verifies the new-recorded events in the historical audit files to check whether they satisfy the requirements of predetermined configuration. Once the system event matches, Swatch will report to the user immediately. Moreover, it can even monitor log file of syslogd (a unix daemon), and respond with suitable solutions when problem arises.

### 2.3.2 Network-Based Auditing System

The mostly utilized Network-based Auditing Systems are as follows:

- TCPdump: It is currently most popular network-based auditing system. TCPdump is an "OSI Certified Open Source Software" [6]. Therefore, any user can download this tool without charge. TCPdump captures the packets traveling on network for analysis. It is able to monitor network users'

(especially the potential hackers) every single activity. However, despite of its convenience and fame, understanding the generated auditing data may rather be difficult.

- Snort: Likewise, snort another free IDS software supported by Open Source. This system has the capability of monitoring the computers of a same domain. It searches through the captured packet data, and perform analysis on the contained information. Snort compares attach pattern with deterministic rules to detect various kinds of attacks. Its core source code is an altered version of tcpdump; hence, the audit files generated also troubled many users.

All in all, analyzing the audit files generated by the present auditing system, especially the network-based, requires the knowledge of network specialist. Due to the fact that packets are directly stored as in raw format, analysis process becomes inconvenient and time-consuming. Also, analysts have to one by one investigate each packet in the audit file. In attempting to solve this problem, this research proposed to introduce the concept of session into the analysis procedure.

## 3. The Proposed System

The present network-based auditing systems are often incapable of performing session analysis. Moreover, records accumulated for a long period of time usually lack in organization and have no meaningful structure. Therefore, it posts a considerable difficulty for the analysts. If these records can be rearranged prior to the analysis process, the complication of the work will be greatly reduced. As a result, analysts would, then, be able to find out unauthorized activities more efficiently. In consideration of the problem and needs, this research proposed "Network-Based Auditing System with session tracking and monitoring".

### 3.1 System Framework

The proposed system followed the traditional network-based IDS framework. In order to capture the transmitting packets, the system must be located between intranet and gateway. As soon as the system is activated, Ethernet interface card will immediately be placed into promiscuous mode, starting to collect the packets. First, the captured packets are automatically processed by network card driver and system kernel. Then, they are sent to the proposed auditing system for further analysis. The system framework is shown in below:

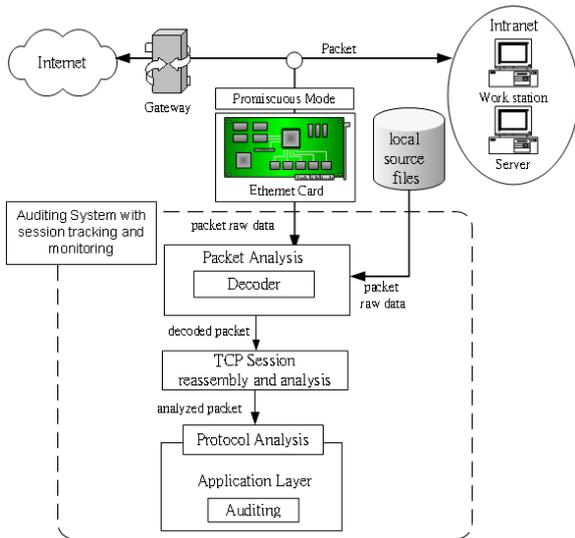


Figure 1. System framework

According to figure 1, the input raw packet data can either be obtained from local source files or packets captured on network. While system is operating on on-line capturing mode, it will keep collecting the packets traveling.

After the packets have been captured they are analyzed and categorized immediately. Meanwhile, the captured raw packets will also be stored in libpcap format (section 4.1) locally for reference in the future. Afterwards, these raw packets will be reassembled, preparing for restoring actual network events and activities.

First of all, raw packet data are sent to packet analyzer module for structure analysis in order to determine individual headers. In addition, the decoder contained within is responsible for converting raw data into understandable textual or numerical format.

The early stage of the analysis focuses only on packets' structure and characteristics. Consequently, the result is simply a collection of raw packets ordered by precedence; therefore, no distinct relationship is established between them. In fact, this is the major problem that creates the complication on analyst's work. In order to overcome this obstacle, it's necessary to design a calculation to rearrange the packets into individual session groups. TCP session analysis module is specifically designed to serve that purpose.

Finally, the analyzed packets will arrive at protocol analysis module. This module is the last module prior to packets' entry into application layer. It determines the packets' protocol type and decides how they will be treated for the later process. At this stage, analysis process will vary in accords to the protocol. This is where the TCP session groups from the previous module are combined into files if applicable. In the end, the analysts will be able to see the actual event be restored. After analytical processes have completed their task, each packet will then be summarized in textual form and stored into an audit file.

### 3.2 TCP Session Analysis and Reassembling

Usually, data will be chopped locally into several pieces prior to its transmission when its length is considered too long. Then, they will be reassembled into its original form after arriving the destination. Hence, packet reassembling is the process of reconstruction and rearrangement of packets base on their individual protocol, characteristics and sequence.

According to figure 2, in TCP layer, the communicating sides must synchronize with each other before any connection is established. This synchronization process is also known as "Three-Way handshaking". Thus, this special interaction procedure signifies each beginning of a new session. Likewise, prior to the end of a session, both sides will inform each other that they are about to close the transmission by sending FIN signal. In other words, every TCP session can be determined by "Three-Way handshaking" and FIN signal. After the beginning and the end of each session are defined, the rest of the packets will be grouped in accords to their IP, port, acknowledge and sequence number.

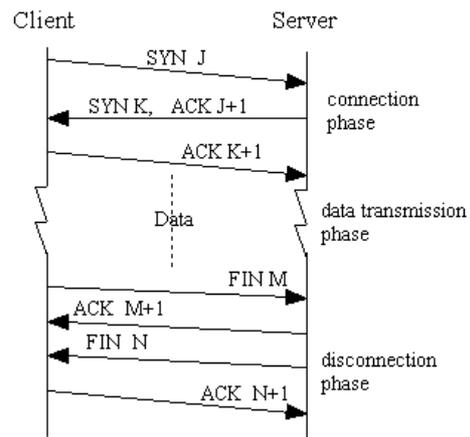


Figure 2. TCP session [13]

Once the session groups have been completely analyzed, reassembly takes place. In this research, attempts are made to simulate the reconstruction process at application level. For HTTP, the restoring process focuses on the commands and files transmitted. For example, a client sent a "GET" request to a web server for an index page file. Then, the server responds with a HTTP message followed by series of packets containing the requested file data. The request and respond packets provide crucial information in the reassembly process. For instance, the name of the requested file can be referenced from the "GET" command line in the request message, and content length can be found in HTTP message. Finally, with the given information and sequence number, the requested file will be generated using the data contained in the packets.

## 4. System Design and Demonstration

The proposed system, “Network-Based Auditing System with session tracking and monitoring”, is developed under Windows and Linux operating system, using interface library WinPcap and Libpcap respectively. Libpcap is a network capture library developed by Network Research Group (NRG) of the Information and Computing Sciences Division (ICSD) at Lawrence Berkeley National Laboratory (LBNL) in Berkeley, California. Libpcap and several other packet analyzing tools are often included as part of the operating system as auxiliaries.

### 4.1 System Design

As what has been mentioned, Libpcap is an interface library, which provides packet capturing function for other applications. It has defined a file format, which the implementing application should apply to. Libpcap

file consists of several sections including “File Header”, “Record Header” and raw packet data; and no paddings in between. Each section header provides information pertaining to its content.

In a libpcap file, the section of the first 24 bytes is called “File Header”, which is followed by many packet records. And, each record consists of 16 bytes “Record-Header” and the contained packet raw data. In other words, a libpcap file has only one “File-Header” but many packet records. A conceptual libpcap log file structure diagram is shown below.

In a libpcap file, the start of each packet record can be determined by record headers. Likewise, this header provides several important information, such as packet length, capture data and time. Applications must recognize the headers in order to access the raw packet data the follows.

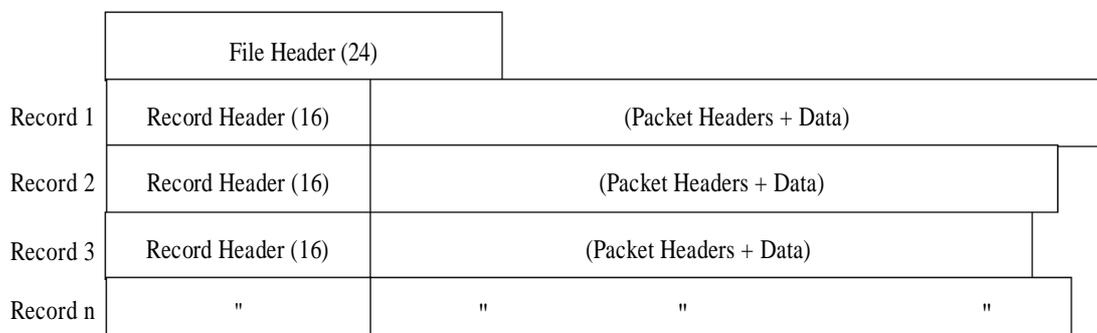


Figure 3. Libpcap file structure

Table 1. File-header format

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
MN				MajV		MinV		TZO				TSA			
LLT				SNP											

Table 2. File-header fields detail

Field	Length (byte)	Meaning
MN	4	Magic Number is a 4 bytes long hex: “0x1a2b3c4d”. The main purpose is for the application, that is reading this file, to determine whether the writing pattern is big-endian or little-endian.
MajV	2	Major Version Number
MinV	2	Minor Version Number
TZO	4	Time Zone Offset
TSA	4	Time Stamp Accuracy
LLT	4	Link Layer Type
SNAP	4	Snap Length: The maximum length of the captured packet data.

Table 3. Record-header format

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
TS								CPL				ACL			

Table 4. Record-header fields detail

Field	Length (byte)	Meaning
TS	8	Time Stamp: The first 4 bytes represents the total seconds from the date of 1970/1/1 00:00:00 up to the time of packet being captured. The next 4 bytes are microsecond.
CPL	4	Captured Length: The length of the packet captured (can be configured).
ACL	4	Actual Length: The actual length of the packet captured.

### 4.2 System Requirements

This system is written in Python; hence, it also supports cross platform. Presently, this system has been tested to operate both on Linux and NT environment. There are a few software requirements. First of all, needs to install Python interpreter version 2.2, and libpcap library for Linux and Winpcap library for NT. There is no required for extra hardware requirement besides Ethernet card. However, a machine that is set up for IDS is, of course, the faster the better, and preferably equipped with larger storage space. That is, high performance hardware is likely to carry out its mission more efficiently.

### 4.3 Scenario: Monitor HTTP As An Example

In order to provide convenient and efficient control, this system has a graphical user interface. Once the system is activated, the user enters the main executing window immediately. In figure 4, sections marked A, B, C, D and E are parameter section, session tracking, packet summary, detailed packet structure tree and raw packet data view. Every system function can be started from this window, which is the core of the whole system. This system works in two different modes: real-time capturing and analyzing mode. Users can directly switch between modes with a mouse click.

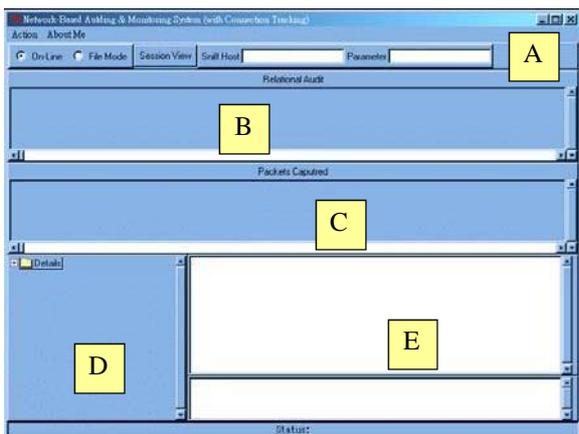


Figure 4. Main executing window

When it is placed into real-time capturing mode, the system will start to capture every incoming and outgoing packet. Of course, network administrator can also enter specific parameters and focus on a particular IP or protocol.

As shown in figure 5, packets that satisfied the defined requirements, will be captured. Filtering out the uninterested packets, the overall analysis accuracy and efficiency will be improved.

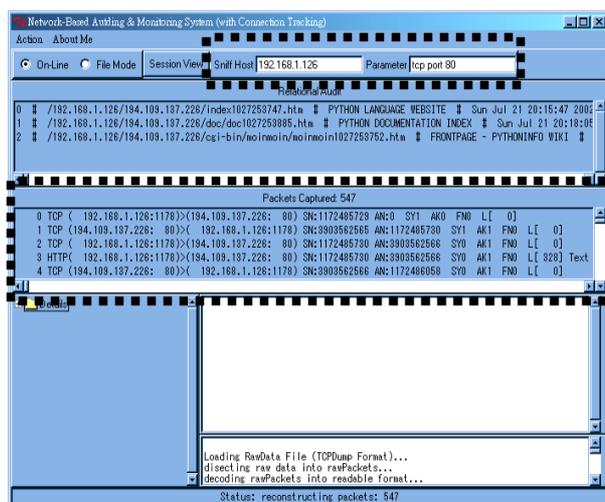


Figure 5. Capturing packets that satisfied the requirements

After packets have been captured, the system immediately takes the responsibility to analyze their structure. The result will be shown in the packet summary section. To see more detailed information about a specific packet, users can simply click on a packet listed in summary section. Then, the complete packet structure (with consisted headers) and raw packet data (in hex format) will be shown (figure 6).

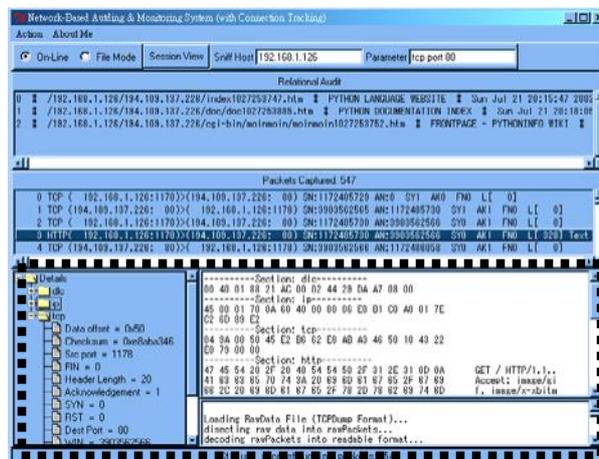


Figure 6. Packet's full detail

This system is also capable of performing session tracking and packet reassembling. That is, the collected packets are processed and reassembled by the system to generate files; for example, a web page. These files will be listed in chronological order in the session tracking section. Users can directly view the file by selecting the listed item. As in HTTP, the files are most likely to be the web pages or graphics. In fact, with this mechanism, the administrators can see the restoration of the actual event occurred and what exactly the monitored users have done. Indeed, this feature can allow administrators to manage the network much more effectively. As shown in figure 7, 8 and 9, the pages browsed by the monitored user are all captured and listed.

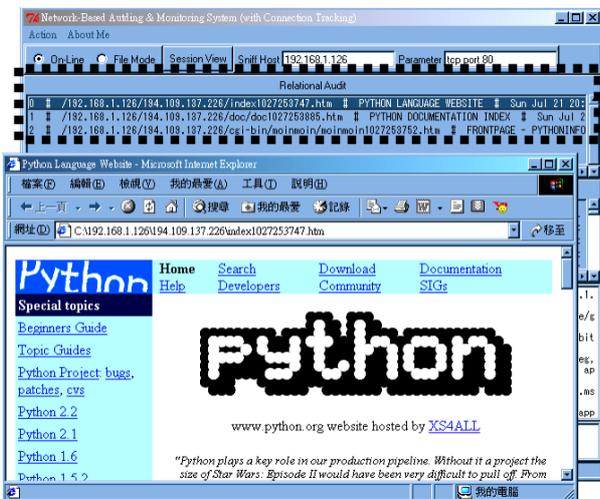


Figure 7. The result of the reassembled packets: web pages browsed by the monitored user

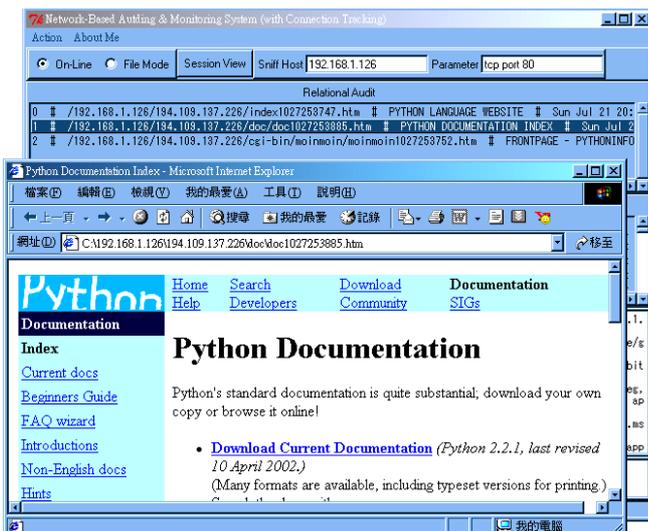


Figure 8. Web pages browsed by the monitored user (continuation)

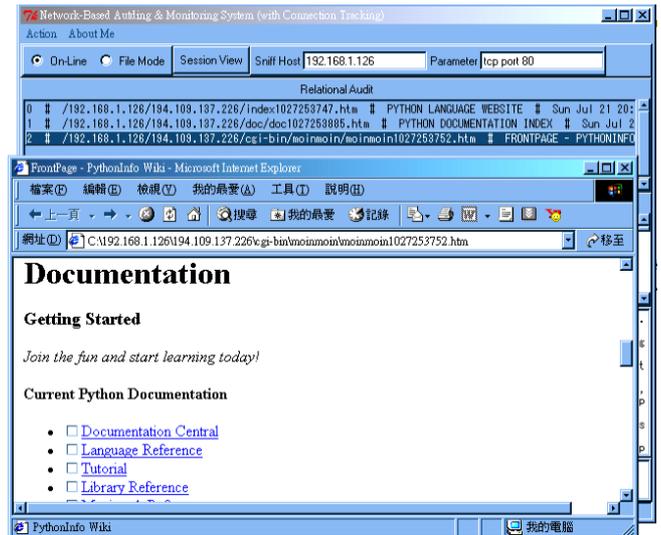


Figure 9. Web pages browsed by the monitored user (continuation)

Other than regular analysis, network administrators can also utilize this system to determine individual session. In figure 10, each session in the session tracking window is grouped by its IP and port (both source and destination). Both total number of consisting packets and the sum of data length are noted behind each session group. After selected a session group from the list, the files that are generated in this session will be listed in the window shown below. Then, by clicking on a specific file, the users are able to see the packets that constitute it (figure 10, 11).

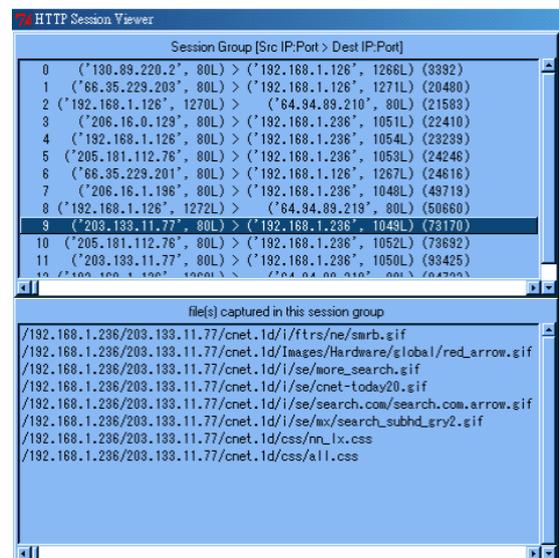


Figure 10. Selecting a desired session group

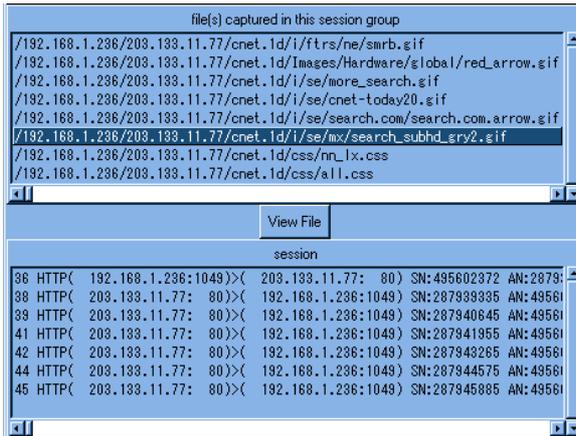


Figure 11. The selected file's consisting packets

Each analyzed packet will be recorded in textual audit files, and these records will become important references for future verification (figure 12).

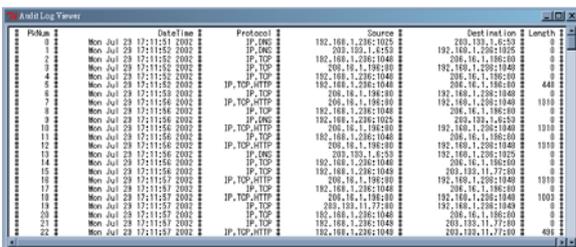


Figure 12. Textual audit file

## 5. Conclusion and Future Improvements

Network security is becoming increasingly important. Besides firewall and intrusion detection measures, enforcing an efficient and effective security mechanism is the key to secure working environment. The importance of IDS should not be ignored. Auditing system will be the crucial monitoring technique towards cyber-crime. In this research, a "Network-Based Auditing System with session tracking and monitoring" is developed. Despite the packets are captured or retrieved from a raw packet source file, the actual monitored network events can be reassembled and replayed.

This system solves the problem of network administrators in overcoming the difficulty in analyzing the audit files. When network attacks occur, the administrator can specify the query time and event to reveal the suspected network activities. These reassembled records will serve as references that can provide great help in tracing the intruders.

In the future research, the system is expected to support more protocols, such as dns, ftp, smtp, pop3 and etc. Also, a through evaluation should be done on the system operating under various network traffic stress in measuring its stability. If necessary, further improvements will be made on this auditing system's efficiency by transforming this centralized system to distributed system.

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## Reference

- [1] Biswanath Mukherjee, L. Todd Hoberlein, and Karl N. Levitt, "Network Intrusion Detection," IEEE Network, May/June, 1994
- [2] Fan, Xiu-Wei et. "The detection and record of abnormal behavior in network", 第六屆資訊管理學術暨警政資訊實務研討會, 2002
- [3] Ghosh, A.K.; Wanken, J.; Charron, F., "Detecting anomalous and unknown intrusions against programs", Computer Security Applications Conference, 1998 Proceedings 14th Annual, 1998
- [4] Gregory B. White, Eric A. Fisch, and Udo W. Pooch, "Cooperating Security Managers: A peer-based Intrusion Detection System", IEEE Network, Jan./Feb. 1996
- [5] <http://netgroup-serv.polito.it/winpcap>
- [6] <http://www.opensource.org/licenses/>
- [7] Jai Sundar, Jose Omar, David Isacoff, Eugene Spafford, and Diego Zamboni, "An Architecture for Intrusion Detection using Autonomous Agents", IEEE 1998
- [8] Keven Richards, "Network based Intrusion Detection: A Review of Technologies", Computer & Security, 18 (1999)
- [9] Lin, Feng-Ming et., "Intrusion Detection: a Network View", TANet2001 Conference, October 2001
- [10] Lunt, T.F.; Jagannathan, R.; Lee, R.; Whitehurst, A.; Listgarten, S. "Knowledge-based intrusion detection", AI Systems in Government Conference, 1989 Proceedings of the Annual, 1989
- [11] Nicholas Puketza, Mandy Chung, Ronald A. Olsson, and Biswanath Mukherjee, "A software platform for testing intrusion detection systems", IEEE software 1997
- [12] Shen, Wen-Chu, "Monitoring and behavior analysis of network security systems" unpublished Master's Thesis, National Taiwan University Management Information Department, 2000
- [13] TCP/IP Illustrated, Volume 1: The Protocols, Addison-Wesley, 1994, ISBN 0-201-63346-9
- [14] Teresa F. Lunt, "Real-time Intrusion Detection", IEEE 1989
- [15] Vigna, G.; Kemmerer, R.A., "NetSTAT: a network-based intrusion detection approach", Computer Security Applications Conference, 1998 Proceedings 14th Annual

# Design of Web-based Security Management for Intrusion Detection

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## Abstract

Electronic business is rapidly popularized and extended through Internet. Internet has many security weaknesses, so we need the security solution such as Intrusion Detection System that minimizes the damage of hacking and responds the intrusion dynamically. It is difficult for legacy management system to process the security environments and electronic business, because legacy system lacks of security policies and integrated security methods. In order to resolve these problems, we need security management system that has standard security policy, consulting, diagnosis, maintenance, and repair function. In this paper, we design and implement Web-based security management for intrusion detection. Our security system consists of network nodes, general hosts and a management node. A management node manages a network node, that is a secure router, and general hosts by security policies. We design the channel between the management node and the network node using IPsec (IP Security). We have applied java and Web to implementing user interface of security system. As the proposed system makes use of Web, security management system is easily accessed through the Web.

## 1. Introduction

Nowadays the business markets of Electronic Commerce (EC) [1] have rapidly extended through Internet. Internet has many security vulnerabilities such as sniffing, spoofing and computer virus. It is necessary to provide the security of Internet services for electronic business. In order to overcome the weakness of Internet, we make good use of security services such as firewall, Virtual Private Network (VPN), Enterprise Security Management (ESM) and Intrusion Detection System (IDS) [2].

IDS is a next generation security solution that minimizes the damage of hacking, in case a firewall fails in the isolation of intrusions, and responds the intrusion dynamically. IDS has three types that are Network based IDS (N-IDS), Host based IDS (H-IDS) and Hybrid IDS. N-IDS is installed in network nodes and analyzes the packet from network nodes. N-IDS has some advantages which are OS independence and the low cost of operations and installation, compared with H-IDS. H-IDS is installed in the server which wants to monitor the network. It monitors the system log files stored by an audit and

system call in the operation level. But H-IDS is difficult to implement and has the high cost of setup, compared with N-IDS. The limits of IDS are the false positive rates of misuses, the process of encryption packets and the hacking by a roundabout way. New advanced filtering technology and rules, updated by well known patterns, are needed to reduce the rates of misuses.

Today's standard of IDS is in progress by consortium and IETF. Internet Security System (ISS), Tripwire software, IBM, and Network Associates joint Intrusion Detection System Consortium (IDSC). IETF Intrusion Detection Working Group (IDWG) [3] defines a data format that exchanges the information of various IDS products.

It is difficult for legacy management system to process the security environments and electronic business, because legacy security management hasn't any security policy [4, 5] or integrated management method. In order to resolve these problems, we need security management system that has standard security policy, consulting, diagnosis, maintenance, and repair function. It is necessary to develop security management technologies that are integrated and can be reconfigured in real-time whenever the network administrator wants.

In this paper, we design and implement Web-based security management for intrusion detection. Our system consists of network nodes, general hosts and a management node through networks. A network node is a security router that provides packet filtering, intrusion detection, intrusion analysis, intrusion response, and policy enforcement. A management node manages network nodes and general hosts by security policies. We design the channel between the management node and the network node using IP Security (IPsec) [6].

This paper is organized as follows. Section 2 describes related works which are Java Server Page (JSP) and IPsec. Section 3 designs the architecture of our system. Section 4 describes the implementation of Web-based security management. Finally, section 5 summarizes this paper.

## 2. Related Work

### 2.1 Java Server Page (JSP)

Java Server Page (JSP) is a technology for controlling the content or appearance of Web pages using servlets. JSP allows Web developers and designers to rapidly develop and easily maintain Web pages that support

existing business systems. JSP enables rapid development of web-based applications that are platform independent. JSP uses XML-like tags and scriptlets written in the Java programming language to encapsulate the logic that generates the content for the page.

Java Server Page is an extension of the Java Servlet technology. Servlet is a small program that runs on a server and platform-independent module. Servlet provides Web developers with a simple, consistent mechanism for extending the functionality of a Web server and for accessing existing business systems. Servlets have made many Web applications possible. JSP is comparable to Microsoft's Active Server Page (ASP) technology. While a Java Server Page calls a Java program that is executed by the Web server, an Active Server Page contains a script that is interpreted by a script interpreter such as VBScript or JScript before the page is sent to the user. An HTML page that contains a link to a Java servlet is sometimes given the file name suffix of .JSP.

## 2.2 IP Security (IPsec)

The research on the next generation Internet is already in progress worldwide. IPsec (IP security), which is a common security service, is proper for characteristics of the Internet as a mandatory technology in next generation Internet IPv6. IPsec provides various security services at the IP layer. It is mandatory to implement IPsec in IPv6 and IPsec provides scalability and interoperability that are required to the Internet security protocol. It is not required to modify the software to use the security services of the IPsec and users don't care about the existence of the IPsec. IPsec is an extension of IP, it has Authentication Header (AH) [7] and Encapsulating Security Payload (ESP) [8]. IPsec can provide Internet security services that are access control, connectionless integrity, rejection of replayed packets, data origin authentication, confidentiality, and limited traffic flow confidentiality.

AH is security protocol that provides security services using message checksum (ICV). ESP is security protocol that offers security services using data encapsulation. AH is used to protect an entire IP payload and ESP is used to protect upper-layer protocols of an IP payload. ESP gives security services to only encapsulated field, but AH provides security service for IP packet. AH and ESP support two modes, transport mode and tunnel mode. Transport mode is used to protect upper-layer protocols and tunnel mode is used to protect entire IP datagram.

IPsec SA is that how to protect the traffic, what traffic to protect, and with whom the protection is performed between host and gateway or end hosts. It is consisted of Security Parameter Index (SPI), destination address and security protocol, AH or ESP. SA decides IPsec protocol as simplex connection entity and IKE negotiates about SAs. Since SA is simplex connection, there exist SA tables according to outbound or inbound processing. SAs are indexed by SPI that exists in IPsec protocol headers, the IPsec protocol value, and the destination address.

## 3. System Design

### 3.1 System Framework

Our system consists of network nodes, general hosts and a management node through networks. The network node is a security router that provides packet filtering, intrusion detection, intrusion analysis, intrusion response, and policy enforcement. The management node manages the network node and general host by security policies. Figure 1 shows the system framework of Web-based security management for intrusion detection. The management node and the network node communicate using IPsec.

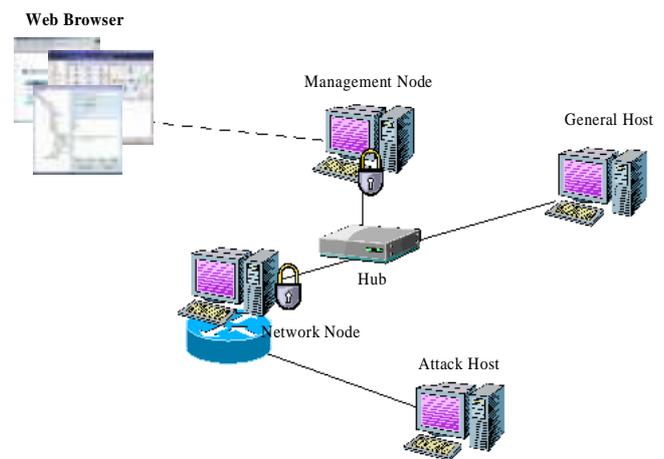


Figure 1. System Framework

### 3.2 Architecture of Management Node

The management node manages the network node and general host by security policies. Management node has management servlets, network sensor, policy decider, policy parser, audit manager, audit handler and databases. Policy DB stores the policy for intrusion detection such as the access rule, filtering rule, and detection rule. The policy parser writes, configures and deletes policies from policy DB. After the policy parser reads the policy DB, the policy decider selects a suitable policy for the network node.

Tomcat 4.0 provides the servlet engine for management servlets. Management servlets, which are executed by tomcat program, communicate with the Web interface. Web interface is Web browser, e.g. Netscape or Internet Explorer. We run Web browser and put the URL of the management node. Then login servlet sends the logon page to Web browser and we can access logon page. After putting ID and password on logon, login servlet checks ID and password from the user DB. If user is authorized, security management program is downloading form Web server. If user is not authorized, Web reloads the logon page.

Figure 2 shows the architecture of the management node. The network sensor collects network information

such as host data, routing data and packet data from networks, and stores at network DB. The audit handler and audit manager deals with the alarm of illegal access, bad packet and intrusion. The network node is a security router that provides packet filtering, intrusion detection, intrusion analysis, intrusion response, audit handle, access control, and policy enforcement. The network node operates intrusion detection by policy and communicates with the management node using IPsec.

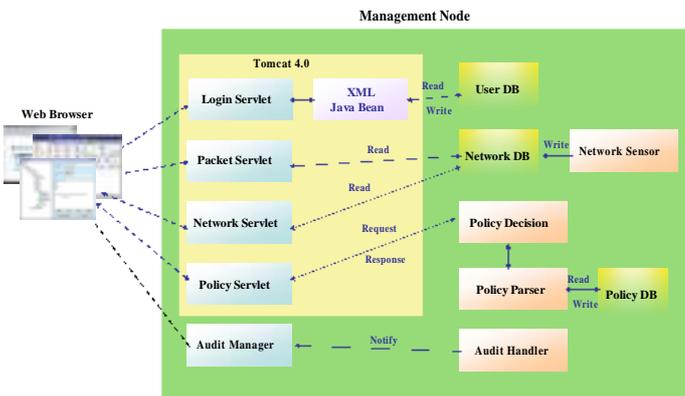


Figure 2. Architecture of Management Node

#### 4. Implementation

We have implemented our system in Linux 7.1 using JDK 1.3.1 [9], JSP server (tomcat) 4.0.3 [10], pcap library 0.4 and gcc 2.96. We can access to security system using Web such as Netscape or Internet Explorer in Windows 2000, Linux or Solaris. A management node configures and deletes policies, and monitors the network. The policy is sent to a network node, then the network node enforces policy, collects packet and analyzes the intrusion detection of networks.

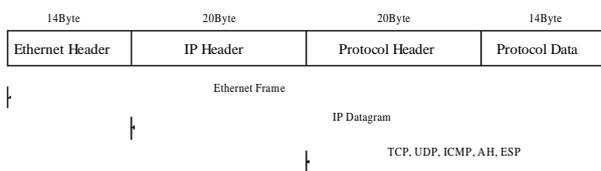


Figure 3. The format of Ethernet Frame

Figure 3 shows the format of Ethernet frame. We define that “default length of snap” is 68bytes of the macro used with the network sensor using pcap library. Length of frame is variable and the minimum length is 68bytes. The minimum length is sum of Ethernet header length, IP header length, TCP header length and protocol data length. Ethernet header is 14bytes, IP header is 20bytes, TCP or UDP header is 20bytes, and the length of protocol data is 14bytes.

```

#define DEFAULT_SNAP_LEN          68
#define DEFAULT_NET_DEV          "eth0"
#define FILTER_RULE_LEN          256
#define ETHER_TRAILER            4
#define LOG_FILE                  "packet_info.log"

static void analyze_packet (unsigned char *user, const struct
pcap_pkthdr *pkthdr, const u_char *p) {
    const struct ip *p_ip;
    const struct ether_header *p_ehdr;
    uint16_t ether_type;

    snap_start = p;
    snap_end = p + pkthdr->caplen - 1;
    set_cur_pkt_timestamp (pkthdr->ts);
    frame_time = pkthdr->ts;
    p_ehdr = (const struct ether_header *)p;
    ether_type = ntohs(p_ehdr->ether_type);
    p_ip = (const struct ip *) (p + sizeof(struct ether_header));
    set_cur_pkt_ether_type (ether_type);
    set_cur_pkt_etheraddr (p_ehdr);

    if (ether_type == ETHERTYPE_IP) {
        set_cur_pkt_ipproto (p_ip->ip_p);
        set_cur_pkt_ipaddr (p_ip->ip_src, p_ip->ip_dst);
        if (is_normal_ip (p_ip)) {
            analyze_ip_datagram ((const u_char *)p_ip +
                sizeof(struct iphdr), p_ip->ip_p);
        }
    }
    next_pkt_entry();
}

static void analyze_ip_datagram (const u_char *p, u_char ip_proto)
{
    switch (ip_proto) {
        case IPPROTO_TCP:
            analyze_tcp (p);
            break;
        case IPPROTO_UDP:
            analyze_udp (p);
            break;
        case IPPROTO_ICMP:
            analyze_icmp (p);
            break;
    }
}

```

The packet is captured from networks, “analyze\_packet()” function classifies the header of the packet. “analyze\_packet()” function finds out source address, destination address, source port, destination port and protocol. “analyze\_ip\_datagram()” function classifies protocol using the protocol field of ip header. If the protocol field of ip header is “IPPROTO\_TCP”, “analyze\_tcp()” function is called. If the protocol field of ip header is “IPPROTO\_UDP”, “analyze\_udp()” function is called. If the protocol field of ip header is “IPPROTO\_ICMP”, “analyze\_icmp()” function is called. The analyzed packet is useful about knowing the intrusion detection, packet traffic, and packet statistics.

#### 5. Conclusion

In this paper, we design Web-based Security Management for Intrusion Detection. Our system consists of network nodes, general hosts, management node through networks. The network node is a security router

that provides packet filtering, intrusion detection, intrusion analysis, intrusion response, and policy enforcement. The management node manages the network node and general hosts by security policies. We have applied java and Web to implementing system. Java is used to program the user interface. As the proposed system makes use of Web, security system is easily accessed through the Web in real time.

## References

- [1] Richard Kee, Roger Walton, Henning Dransfeld, and Nick Harman, *Ovum Forecast the Internet and E-commerce*, Ovum, July 2000.
- [2] Stephen Northcutt and Judy Novak, *Network Intrusion Detection. An Analyst's Handbook*, 2nd ed. New Riders, 2001.
- [3] IETF Intrusion Detection Working Group  
<http://www.ietf.org/html.charters/idwg-charter.html>
- [4] IETF Policy Working Group  
<http://www.ietf.org/html.charters/policy-charter.html>
- [5] D. Durham, J. Boyle, R. Cohen, S. Herzog, R. Rajan, and A. Sastry, The Common Open Policy Service Protocol: RFC 2748, January 2000.  
<http://www.ietf.org/rfc/rfc2748.txt>
- [6] S. Kent and R. Atkinson, Security Architecture for the Internet Protocol: RFC 2401, November 1998  
<http://www.ietf.org/rfc/rfc2401.txt>
- [7] S. Kent and R. Atkinson, IP Authentication Header: RFC 2402, November 1998.  
<http://www.ietf.org/rfc/rfc2402.txt>
- [8] S. Kent and R. Atkinson, IP Encapsulation Security Payload: RFC 2406, November 1998.  
<http://www.ietf.org/rfc/rfc2406.txt>
- [9] JDK Homepage, <http://java.sun.com/>
- [10] Jakarta Homepage, <http://jakarta.apache.org/>
- [11] S. H. Jo, J. H. Nah, & S. W. Sohn, "Internet Security Management System for IPsec," *Proceeding of NordU2002/USENIX Conference*, Helsinki, Finland, February 2002.

# Security of Deputy Signature

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## Abstract

E-system, a new commerce model, is a new era for business direction. When a principal is absent (goes on an errand or on leave), a well-designed deputy system keeps the business operations working. In the network world, identity verification and any substitute for traditional signature can be done by digital signature [1]. Deputy signature guarantees the existence of deputy system in e-system. Current deputy mechanism addresses the verification of deputy signature. No research has been done on the prevention of the illegal use of deputy system when the principal returns and the deputy system is not in use. We propose a mechanism to solve the problem of illegal use of deputy system when the power of deputy system is not legally "ON."

Key words: information security, digital signature, deputy signature.

## 1. Introduction

In the information era, information technology is an important tool to support all work. The popularity of network changes the methods of information transfer and speeds up the development of e-commerce. As a new model of commerce, e-commercialization is a competitive goal for all business users. A well-designed deputy system is helpful to business operations in non-network system and is imperative in network system.

In a network environment, in addition to verifying the identity, digital signature can also be used to substitute for the traditional handwritten signature. During the principal's absence, deputy signature keeps the system running and the security of private key as well. The characteristics of deputy signature are as follows: private, identifiable, secure, and undeniable. Current deputy mechanism addresses the verification of deputy signature. No research has been done on the prevention of the illegal use of deputy system when deputy system is not in use. We propose a mechanism to solve the problem of illegal use of deputy system when the power of deputy system is not legally "ON." Our scheme provides a delegation time schedule for the receiver to solve the associated problem of deputy signature. Unauthorized deputy will be ruled out once

the principal returns and the deputy's authority has lapsed.

The layout of this paper is as follows. Literature review is in Section 2. Section 3 introduces our scheme. In Section 4, we analyze the security of our scheme. Section 5 concludes the paper.

## 2. Literature Review

Digital signature fulfills the requirement of signature in network environment and enhances the feasibility of e-commerce. In the E-era, the un-deniability of digital signature enables e-documents to be widely and legally accepted. The principal uses his/her private key to sign and send documents. The receivers verify the documents by public key. When one cannot sign documents personally, deputy signature enables the deputy to keep the system working without using the original private key. Mambo et al [2,3] propose deputy signature in 1996. Deputy signature allows deputy to sign documents with equal efficacy. In general, deputy signature has properties as follows [11]:

- A. Distinguish-ability: The difference between deputy signature and original signature is distinguishable.
- B. Unforgeability: No one else can forge deputy signature other than the real deputy.
- C. Verifiability: The receiver(s) can believe that the principal agrees to deputy signature for the documents.
- D. Un-deniability: deputy cannot deny deputy signature. Unfortunately, the Mambo deputy signature is deniable. Zhang [4], Lee et al [5], Sun and Hsieh [6] solve this problem in their schemes.

## 3. Our Scheme

### 3.1 Registration

First, firm should set up a system center. The manager of system center chooses a big prime  $p$  [7,8,9] to satisfy the following equations:

$$p = 4p_1q_1 + 1$$

where  $p_1, q_1$  are big primes.

Let  $n = p_1q_1$

Then, select a number  $g$  modulo  $p$  with order  $n$ , i.e.,  $g^n \equiv 1 \pmod{p}$ ,  $g^{p_1} \not\equiv 1 \pmod{p}$ ,  $g^{q_1} \not\equiv 1 \pmod{p}$ .

$\{p,n,g\}$  is the public key of the system center.  $\{p_1,q_1\}$  is private key.  
 The principal (hereafter A) selects a number  $x_A \in Z_n^*$  calculates:

$$y_A \equiv g^{x_A} \pmod{p} \dots\dots\dots(1)$$

and registers to system center.  $\{y_A\} \{x_A\}$  are the public key of A and private key, respectively.

If A is to assign B as his/her deputy to sign documents during  $T_A = [t_1, t_2]$ . B selects a number  $x_B \in Z_n^*$ ,

calculates:

$$y_B \equiv g^{x_B} \pmod{p} \dots\dots\dots(2)$$

and registers to system center, where  $\{y_B\} \{x_B\}$  are the public key of B and private key, respectively.

### 3.2 Delegation

**Step 1:** A selects a number  $d_1 \in Z_n^*$  and calculates:

$$D_1 \equiv g^{d_1} \pmod{p} \dots\dots\dots(3)$$

**Step 2:** Calculate:

$$y_B + T_A \equiv x_A D_1 + d_1 E_1 \pmod{n} \dots\dots\dots(4)$$

**Step 3:** Send deputy certificate  $\{T_A, D_1, E_1\}$  to B as shown in Diagram 1.

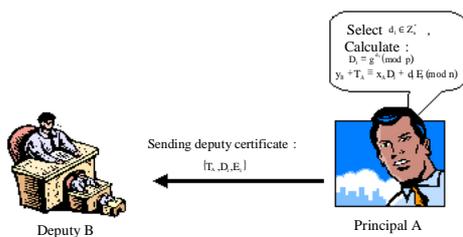


Diagram 1: Delegating deputy and sending deputy certificate

### 3.3 Generation of deputy signature

If B is going to sign on the message m during deputy time,

**Step 1:** Select a number  $d_2 \in Z_n^*$  and calculate:

$$D_2 \equiv g^{d_2} \pmod{p} \dots\dots\dots(5)$$

**Step 2:** Calculate:

$$E_2 \equiv mx_B + d_2 D_2 \pmod{p} \dots\dots\dots(6)$$

**Step 3:** Sending deputy certificate  $\{T_A, D_1, E_1\}$  and the digital signature  $\{m, D_2, E_2\}$  with message m to a receiver C as shown in Diagram 2.

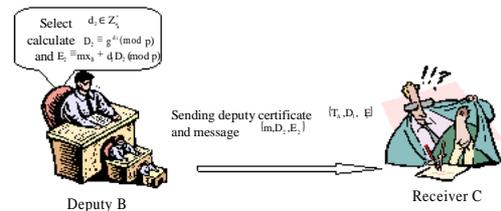


Diagram 2: Running of Deputy signature

### 3.4 Verification of deputy signature

The receiver C verifies:

$$g^{y_B + T_A} \equiv y_0^{D_1} D_1^{E_1} \pmod{p} \dots\dots\dots(7)$$

$$g^{E_2} \equiv y_B^m D_2^{D_2} \pmod{p} \dots\dots\dots(8)$$

If the equations above are valid, accept deputy B. If not, reject.

## 4. Security Analyses

**Theorem 1:** If A is honest, Eqs.(7)(8) are valid.

**Proof:**

To have base g for the both sides of Eq.(4) and obtain:

$$g^{y_B + T_A} \equiv g^{x_A D_1} g^{d_1 E_1} \pmod{p} \\ \equiv y_A^{D_1} D_1^{E_1} \pmod{p}$$

According to Eqs.(1)(3)

For the same reason, having base g for both sides of Eq.(6) and obtaining:

$$g^{E_2} \equiv g^{mx_B} g^{d_2 D_2} \pmod{p} \\ \equiv y_B^m D_2^{D_2} \pmod{p}$$

According to Eqs.(2)(5), the theorem 1 is proven.

**Theorem 2:** The difficulty of forging Eq.(1) is the complexity of discrete logarithm

**Proof:**

ElGamal [10] has proven that following equations to be discrete logarithm:

$$g^m \equiv y^r s \pmod{p} \dots\dots\dots(9)$$

Comparing Eq.(7) and Eq.(9), we find that if

$$y_B + T_A \equiv m \pmod{n} \dots\dots\dots(10)$$

then Eq.(7) is similar to Eq.(9). Namely, the complexity of Eq.(9) is discrete logarithm. So is Eq.(10). On the contrary, if Eq.(10) is the problem of discrete logarithm, So is Eq.(9). In addition, the complexity of forging Eq.(8) is at least equal to the complexity of Eq.(7). The proof is similar and omitted. Thus, theorem 2 is proven.

From the two theorems above, we know that if an attacker (A or B) is going to invade our system, he/she has to solve the complexity of discrete logarithm.

## 5. Conclusion

In recent years, along with the development of network, e-commerce is expanding rapidly. In addition to overturning the traditional model of transactions, this new business activity also provides ample business opportunity. Network is used for business activities and generates e-business. For e-business, information security is an important topic. In a non-e environment, deputy system can be done by written delegation certificate. In an e-environment, a trustable deputy signature is needed. Our deputy signature has the advantage of timing for the verification of deputy signature. No illegal deputy can be accepted once the principal returns and the deputy's authority has lapsed.

## References

- [1] Rivest R. L., Shamir A., and Adleman L., "A method for obtaining digital signatures and public key cryptosystems," *Communications of the ACM*, Vol.21, No.2, pp.120-126, 1978.
- [2] MAMBO, Masahiro, USUDA, Keisuke, and OKAMOTO, Eiji (1996b): "Proxy Signatures for Delegation Signing Operation," *Proceedings of third ACM Conference on Computer and Communications Security*, New Delhi, pp. 48-57, 1996
- [3] MAMBO, Masahiro, USUDA, Keisuke, and OKAMOTO, Eiji (1996a): "Proxy Signatures: Delegation of the Power to Sign Message," *IEICE. Transaction Fundamentals*, Vol. E 79-A, no. 9, pp.1338-1354, 1996
- [4] Zhang K., "Threshold Proxy Signature Schemes," *1997 Information Security Workshop*, Japan, Sep. 1997, pp. 191-199.
- [5] Lee N. Y., Hwang T. and Wang C. H., "On Zhang's nonrepudiable Proxy Signature Schemes," *Third Australasian Conference, ACISP '98*, 1998, pp. 415-422.
- [6] Sun H. M., Hsieh B. T., "Remarks on two nonrepudiable proxy signature schemes," *Ninth National Conference on Information Security*, Taiwan, 1999, pp. 241-246.
- [7] Gordon, "Strong RSA Key," *Electronics Letters*, Vol.20, pp.514, 1984.
- [8] Harn L., "Public-key Cryptosystem Based on Factoring and Discrete Logarithms," *IEE Proc.-Comput. Digit. Tech.*, Vol.141, No.3, pp. 193-195, 1994.
- [9] Tu K., "Comment: Public-Key Cryptosystem Design Based on Factoring and Discrete Logarithms," *IEE Proc.-Comput. Digit Tech.*, Vol.143, No.1, 1996.
- [10] ElGamal T., "A public key cryptosystem and a signature scheme based on the discrete logarithm," *IEEE Transactions on Information Theory*, Vol.31, pp.469-472, 1985.
- [11] 陳炳彰,孫宏民,黃宗立,"代理簽章之發展與演進", *資訊安全通訊*, Vol.7, No.3, June 2001

# Multiple Phases of Adopting Extranet by Business Networks: A Study of Plastics Industry in Taiwan

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## Abstract

Extranet has received growing popularity among business-to-business trading partners today. It has been used to reduce delivery lead-time and improve customer service. The inter-organization nature of Extranet, coupled with the omnipresence of Internet, create competitive advantages for a company over those who do not have Extranet linkage. This study investigates the factors affecting the adoption of Extranet in rubbers and plastics industry. The results reveal that "characteristics of end user" is the most importance factor affecting the adoption. The other significant factors include the characteristics of business itself, degree of understanding new technology, the characteristics of business network, and the support of top management.

## 1. Introduction

Electronic network linkages in the value chain have fundamentally changed the nature of inter-organizational relationships (McIvor et al., 2000). Many companies today are sharing their information resources through a competent network infrastructure, known as the Extranet. Internet has been commonly known as the first revolution of network, followed by Intranet and Extranet. More and more businesses are redesigning their internal structure and their external relationships, creating value chain networks to facilitate improvement of information quality, communication of data, and knowledge, while improving coordination, planning, and decision making (Warkentin et al., 2001). Under today's dynamic business environment, competitive pressures are forcing companies to take necessary actions on compressing time between each stage of the value chain and achieving costs down (McIvor et al., 2000). Many companies have utilized information technology to create competitive advantages (Bakos and Treacy, 1986; Cash, et al., 1992. Ives and Learmonth, 1984). They have been upgrading their enterprise information systems to improve the efficiency and the effectiveness of supply chain networks. The inter-organization nature of Extranet has made it a vital vehicle for maintaining these networks. In this study, we first identify the potential factors affecting the adoption of Extranet. Through factor analysis and discriminant

analysis, these factors are tested for their significant effects. Finally, conclusion and recommendation for managers are presented.

## 2. The Research Methodology

### 2.1 Research Model

Through the review of related literature, we have developed a research model as indicated in Figure 1.

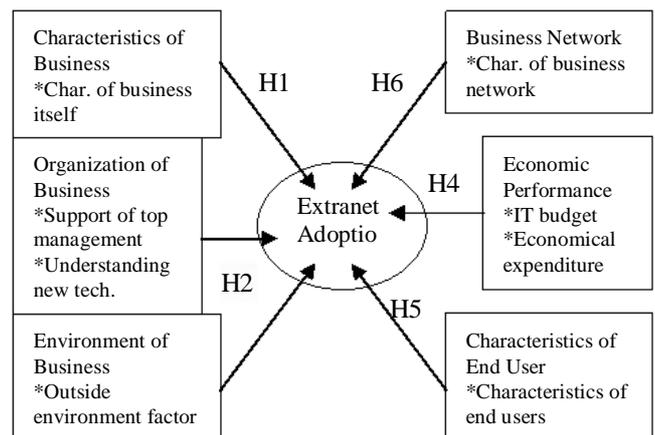


Figure 1. Research Model

### 2.2 Research hypothesis

Following the research model in Figure 1, we have formulated six hypothesis.

H1: The characteristics of business affect the adoption of Extranet in an enterprise.

H2: The organization of business affects the adoption of Extranet in an enterprise.

H2a: The support of top management affects the adoption of Extranet in an enterprise.

H2b: Understanding new technology affects the adoption of Extranet in an enterprise.

H3: The environment of business affects the adoption of Extranet in an enterprise

H3a: Outside environment factor affects the adoption of Extranet in an enterprise.

H3b: Outside environment threat affects the adoption

of Extranet in an enterprise.

H4: The economic performance of business affects the adoption of Extranet in an enterprise.

H4a: IT budget affects the adoption of Extranet in an enterprise.

H4b: Economical expenditure affects the adoption of Extranet in an enterprise.

H5: Characteristics of end user affect the adoption of Extranet in an enterprise.

H6: Business network affects the adoption of Extranet in an enterprise.

### 3.3 Data Analyses and Hypothesis Tests

This section utilizes difference analyses to test the hypotheses and reports the results.

#### 3.3.1 Different Discriminant functions

In addition to the discriminant loading, we further utilize profile group difference, discriminate weight, and individual discriminate weight to contrast the findings and identify the most significant factor determining the adoption of Extranet. Table 4 shows that “Characteristics of end user” is the most significant factor.

Table 4. Summary of methods used in this study

Method	Criterion	Results
Profile group difference	The difference of variable mean	Understanding new technology
Loading	The weight of loading values	Characteristics of end user
Discriminate Weight	The amount of Weight values	Characteristics of end user
Individual Discriminate Weight	The difference of variable mean	Characteristics of end user

#### 3.3.2 The Accuracy of Discriminant Function

In order to examine the accuracy of the discriminant function, 50 (33.3%) respondents were held out as for validation purpose. The remaining 100 respondents are use as the training sample to derive the discriminant function. Table 5 indicates that the resulting discriminant function is able to classify correctly 80% of the held-out sample. This value (0.80) is larger than the threshold ( $C_{pro} * 1.25 = 0.545$ ) recommended by Hair et al. (1995). Therefore, the discriminant function we derived in this study has significant discriminant power.

Table 5. The accuracy of discriminant function

Training sample			Held-out sample				
Not adopt	Adopted		Not adopt	Adopted	Summary		
Not adopt	36	22	58	Not adopt	28	6	34
Adopted	11	31	42	Adopted	4	12	16
Overall accuracy = 67%			Overall accuracy = 80%				

## 4. Discussion

This study focuses on rubbers and plastics

relationship industries that there are a lots of factors of itself and influence to adopt Extranet. Following these influence factors to do discussion.

### 4.1 Character of business

The result was displayed on adopt extranet, characteristic of business, understanding new technology and characteristic of end user that these functions enable to keep heavy discrimination power. But the characteristic of business network and support of top management that two items functions to adopt extranet also to keep significations discrimination effect (see figure 2). The enterprise dependents IT more heavy than technology efficiency was powerful. Opposite, the others efficiency is weak (Applegate et al., 1996). Following in analysis data have got characteristic of business to adopt extranet discriminate effectiveness p-values is 0.0032 that less standard values 0.05, the result is supported H1 hypothesis.

### 4.2 Business organization

Asano (1989) at his research have argued many enterprise executive e-business technology there are signification difference of development. In this data also examine literature view point, the support of top management affects the adoption of Extranet in an enterprise. It's p-values is 0.0223. Pinto and Mantel (1990) have expressed administrator and end-user low ideals and acknowledges to IT, it should be influence enterprise adopting IT. This analysis data have developed that understanding new technology affects the adoption of Extranet in an enterprise. The p-values is 0.0016 to keep more discriminate power. This result is supported H2 hypothesis (see table 6).

Table 6. Results of Hypothesis Testing

Hypothesis	p-Value	Test Result
H1: The characteristics of business affect the adoption of Extranet in an enterprise.	0.0032	Supported
H2: The organization of business affects the adoption of Extranet in an enterprise.	N/A	Supported
H2a: The support of top management affects the adoption of Extranet in an enterprise.	0.0223	Supported
H2b: Understanding new technology affects the adoption of Extranet in an enterprise.	0.0016	Supported
H3: The environment of business affects the adoption of Extranet in an enterprise	N/A	Not supported
H3a: Outside environment factor affects the adoption of Extranet in an enterprise.	0.0868	Not supported
H3b: Outside environment threat affects the adoption of Extranet in an enterprise.	0.0709	Not supported

H4: The economic performance of business affects the adoption of Extranet in an enterprise.	N/A	Not supported
H4a: IT budget affects the adoption of Extranet in an enterprise.	0.3441	Not supported
H4b: Economical expenditure affects the adoption of Extranet in an enterprise.	0.6658	Not supported
H5: Characteristics of end user affect the adoption of Extranet in an enterprise.	0.0007	Supported
H6: Business network affects the adoption of Extranet in an enterprise.	0.0257	Supported

### 4.3 Business environment

How to succeed in today's rapidly changing competitive environment is a question weighing heavily on many a manager's mind. The business competitive environment more multiples than IT roles more key issues of business environment (Hannan, McDowell, 1984; Levinet, et al., 1987). In the data showed as outside environment factor and outside environment threat that affects the adoption of Extranet in an enterprise. The p-values is 0.0867 and 0.0709 (see table 6). Also this research not support H3 hypothesis.

### 4.4 Economic performance

Competitive pressures are forcing enterprises to take available actions to compress time between each stage of the supply chain and costs down (McIvor et al., 2000). Ives and Jarvenpaa (1991) have argued when the enterprise beginning adopt computerize. IT equipment cost is adopt information systems one of successful issue factors. This data showed as IT budget and economical expenditure affects the adoption of Extranet in an enterprise. The p-values is 0.3441 and 0.6588 (see table 6). Also this research not support H4 hypothesis.

### 4.5 Character of end user

Pinto and mantel (1990) appealed to the research, the experience, profession technology and understand IT knowledge of end user, these factors enable influence business successful adopt IT equipments. Morris and Trotter (1990) research end user and IT adopt have argued accept new IT degree, learning new technology interest of end user, these factors become business adopt IT successful key issue. Hendry (1989) also have argued enterprise focus staff growth, training education degree, enable influence end user operation IT interest. The result was showed the characteristics of end user affect the adoption of Extranet in an enterprise. The p-values is 0.0007 more less than standard 0.05, so this result supported H5 hypothesis.

### 4.6 Character of business network

Erenguc, Simpson, and Vakharia (1999) review the effective management of operations using SCM. They suggest that a firm's competitive position and the nature of

the relationship among SCM participants play a significant role. They also explain why the determination of contractual agreements between the channel members and the incentive structures for information sharing should be further researched. Johnson and Mattson (1987) have argued that business network is one group firm was depended by each other, and rely on long-turn benefit for each relationship. In business network not only keeps competitive and compensation but also has exchange and adaptive interaction relationship.

This data showed as business network affects the adoption of Extranet in an enterprise. The p-values is 0.0257 (see table 6). Because this research support H6 hypothesis that business network affect the adoption of Extranet.

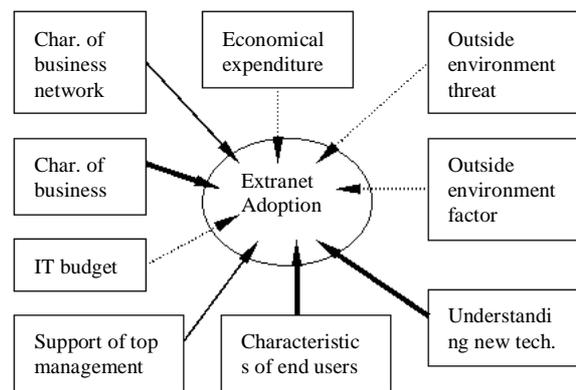


Figure 2. Discrimination

Heavy power: **→** General: **→** Weak: **→**

## 5. Conclusion and Recommendation

Under today's ever-increasing competitive pressure, the quest for competitive advantages has been the vital action of every business. Many success stories have been told in the literature regarding the use of information technologies by businesses to improve the competitive edge. In particular, the Extranet has been an outstanding tool for a business to exchange and share information among inter-organizational partners within a business network. Our study has revealed the critical factors that influence Extranet adoption of a business. Both the characteristics of end user and the characteristics of business itself are the two factors most significantly affect Extranet adoption.

Another two factors of significant importance are the support of top management and understanding of new technology. It is apparent that the degree of understanding new technology would directly affect the support of top management toward adoption of new technology. Therefore, we strongly recommend top management to tirelessly capture new knowledge and establish a culture of learning organization. This in turn would increase the users' interest in learning and using new technology and increase the chance of success in introducing a new technology into the company.

# Business-to-Business Solutions for a Changing Scenario in Brazilian Economy

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## Abstract

This paper has the purpose of describing the development of Business-to-Business in Brazil and its adoption by companies and the government to reduce costs and reach new markets. It also shows the support provided by the Brazilian Government to this development, by means of the creation of the Electronic Commerce Executive Committee, in a joint effort with the private sector, and the implantation of a financing instrument for small and medium companies destined to electronic commerce, among other measures. Examples of creative solutions adapted to the conditions of the Brazilian economy, such as the Energy Marketplaces, established during the electric-energy rationing in Brazil, between May 2001 and February 2002, where thousands of companies were able to commercialize their energy quotas by means of electronic auctions, as well as tools directed to the governmental acquisition of goods and services, show the great potential of Business-to-Business.

## 1. Introduction

The promise that Internet enterprises would change the face of the economy in the early years of the new century seems to have fallen apart. The disastrous performance of stocks of technology companies at Nasdaq, the slow increase in electronic-commerce sales of virtual stores and the difficulties of portals to generate revenues have produced a general bad feeling about everything related to the Web.

A study carried out by Forrester Research, a company focused on identifying and analyzing new tendencies in technology and their impact on business, has shown that the American economic crisis of 2001 and the problems presented above have not discouraged senior executives in the USA from joining electronic business between companies, also known as Business-to-Business, or B2B. While 85% of executives state that one of their top priorities is to find a way to work closer to their business co-partners and clients, 38% classify such integration strategy as vital to the health of their business.[9]

Business-to-Business is the electronic-commerce segment with the highest potential growth in the world, according to the analysis of research institutes specialized in the Information Technology segment. Such tendency is

being confirmed by all studies published by leading research institutes. International Data Corporation, IDC, has revealed that the amount of transactions made by corporations by means of e-commerce solutions should increase from US\$ 282 billion in 2000 to around US\$ 4.3 trillion in 2005, which represents an average yearly increase of 73% in this period.[10] As stated by the Gartner Group, an American research institute, Business-to-Business will represent, in the next three years, 7% of the global economy, or something around US\$ 7.3 trillion.[14] Although growth estimations for B2B vary significantly among the several research institutes, depending on the assumptions adopted, all of them confirm such increase tendency.

According to Jupiter Media Metrix, the automotive industry will have an essential role in the growth of e-business. The institute says that, by 2005, almost 50% of Business-to-Business transactions in the automotive sector will take place online.[11] The institute also states that other segments that should present significant growth are Computer Science, Telecommunications, Chemistry and Defense.

This same tendency has been noticed among Brazilian companies. According to a poll conducted by IDC in 2001, from the total number of companies questioned that still did not have a site in the Internet, 57% of them intended to create one within the next twelve months.[8] In large companies from different segments, although their total Internet-generated revenues were not greater than 2%, they expected to double such number in the year 2001. To 27.5% of the poll's participants, the integration of their business with the Internet is among their top three priorities, since this process represents a means of supporting sales and communications with clients. The financial sector has placed such integration as its first priority.[8]

According to a study carried out by Fundação Getulio Vargas, a Brazilian research institution focused on economy, and by the Giga Information Group, an international consultancy firm devoted to the Information Technology field, Brazil is ahead of other Latin-American nations in the development of electronic commerce. They have noticed, however, that the participation of companies in e-commerce is still low: 1.18% in Business-to-Business transactions and 0.35% in Business-to-Consumer transactions. In some specific segments, such as online banking and the automotive industry, Brazil is among the best in the world. The above

institutes highlight bank Bradesco and Volkswagen as prominent examples. The latter is currently performing 90% of its transactions with suppliers and dealers online.[2]

## **2. The Government Encouraging B2B in Brazil**

Aware of the importance of Business-to-Business, the Brazilian government has created, in 2000, the Electronic Commerce Executive Committee, which works primarily as an interface between public and private sectors. The public sector is represented by the Ministries of Finance, Foreign Affairs and Communications, as well as Anatel – National Telecommunications Agency, responsible for implementing the national policies in the telecommunications field and for regulating corporate activities in the segment. The private sector is represented by the Brazilian Federations of Industry, Commerce, Transports, Agriculture and Exports, the Brazilian Federation of Bank Associations, Software Associations, and a representative of the scientific community, among others. The Committee's main goal is to understand and speed up the development of electronic commerce in Brazil.

The Electronic Commerce Executive Committee is constituted by six thematic subcommittees, which, directed by the private sector, are responsible for elaborating and open to discussion the contributions of entities represented in the Committee. Such discussions yield projects and recommendations, which are taken to the competent organisms and result in the revision of norms and regulations, in the adoption of technical standards, etc., apart from the examination of propositions made by the general public. The subcommittees are the following:

- I- Subcommittee on Forms of Payment for Electronic Commerce: infrastructure for communications, forms of payment and security of electronic transactions;
- II- Subcommittee on Logistics and Regional Integration for Electronic Commerce: logistics, distribution, regional access, costs, investments, legislation and statistics relative to transportation for electronic commerce;
- III- Subcommittee on Economy and International Aspects of Electronic Commerce: investments, financing, costs, legislation, statistics, international agreements and intellectual property;
- IV- Subcommittee on Technologies and Products for Electronic Commerce: technologies, products and services for electronic commerce;
- V- Subcommittee on Electronic Commerce for Small- and Medium-Sized Companies.

## **3. The Development of B2B in Brazil**

The consultancy company KPMG estimates that Business-to-Business will represent US\$ 60 billion in the next three years in Latin America only,[14] and a study

made by Serasa, one of the largest companies specialized in economic, financial and registration analyses and information in the world, assures that virtual deals among Brazilian companies will also increase to rates above 50%.

According to the e-commerce manager of Microsoft in Brazil, the B2B market in Brazil in the next four years will be of over US\$ 50 billion. Around 70% of the companies assure they intend to invest in this segment. An example that this segment is undergoing a good moment was the recent creation of the Springer marketplace. Springer is the largest manufacturer of air conditioners in Brazil. Even with the Brazilian energy crisis, at the end of the year 2001, combined with the global situation, the company has decided to invest in the online segment, creating a marketplace and trusting on increasing sales of its products during the Summer.[14]

The development of Business-to-Business is being pushed forward by the need to reduce costs, increase efficiency and establish a closer contact with suppliers and sales channels. It is also a consequence of the establishment of a new business culture based on trust in the electronic media. However, vital questions such as the existing technology, the integration of Web environments with current systems, the means of communication, the effective transactions among different groups of suppliers, distributors, clients and the government, as well as long-established corporate policies tend to restrain the progress of electronic commerce. According to the poll by Jupiter Media Metrix, leading companies are convinced that B2B portals are useful, but they do not make deals through the Web because their providers still do not take part in large corporate marketplaces. 60% of purchase agents claim that the main obstacle to online shopping is that their preferred providers do not work via the Internet, and 55% of them say that lack of knowledge about online markets prevents them from entering such markets. To 45% of them, lack of trust is the second most common reason to explain the slow increase of Business-to-Business transactions. Favoring the development of B2B, 71% of the participants mention cost reduction as the main benefit of online commerce, while 56% mention fast search for products.[13]

The strong competition in Business-to-Business and the high costs of the technology involved have jeopardized the survival of many companies in this market. By means of partnerships with firms specialized in the different types of technology that integrate electronic commerce, it is possible to obtain high-quality technology and services, assuring system integration and commercial quality in the procedures of acquisition and distribution of goods and services. Examples of such partnerships include: full e-procurement services, purchase management, development and maintenance of supply agreements, technological platforms for electronic commerce via the Internet, management of means of payment, logistical managing, delivery tracking, consultancy in corporate credit and financing operations, and services of authentication, validation and payments through the Internet. To Jonathan Gibs, researcher at

Jupiter Media Metrix, independent online industrial marketplaces must seek to be acquired or to join greater companies in the regional B2B scenario to avoid the risk of being left behind in the competition. Gibs highlights three potential partners for an independent online marketplace:[1]

- Large offline agents in their respective industrial sectors, to which the independent companies may act as an online channel;

- Large B2B portals supported by several companies in a particular industrial sector – the so-called ISM, Industry-Sponsored Marketplaces;

- Subsidiaries of large corporations.

A successful example of Gibs' suggestion is Webb Negócios Online ([www.webb.com](http://www.webb.com)), a Brazilian initiative taken by an enterprising group with great ability to attract partners. In order to offer high-quality technology and services, assuring system integration and commercial quality in acquisition and distribution procedures, it has established partnerships with leading market companies in different segments.

Another example worth mentioning is Agrega, a portal jointly developed by AmBev, a large Brazilian beer producer, and Souza Cruz, the greatest cigarette manufacturer in Brazil. The high costs of implementation, maintenance and update of B2B solutions have taken these companies to share one same sector of acquisition of indirect goods and services.[6] Agrega works in the provider end, integrating the value chain of the companies involved only with the purchase of MRO (Maintenance, Repairs and Operations).

Traditionally, purchases of services and indirect materials were left to a second plan in most companies. This treatment can be explained by the low strategic importance involved in such purchases due to the diversity of items involved and the lack of technological tools that allowed dealing, at a relatively low cost, with such complexity. With the advent of the Internet and the development of e-procurement tools, this whole process can now be implemented at a relatively low cost, by means of introducing e-procurement solutions connected to marketplaces in the Internet. On the other hand, despite the rationalization and elimination of paperwork, and of the increase in the base of suppliers allowed by this technology, it does not replace the purchaser's task of identifying and characterizing the demand and, from it, establishing the best acquisition strategy. Concerning strategic business such the supply of raw materials for beer, or tobacco to manufacture cigarettes, it is the responsibility of the companies and cannot be the purpose of the portal.[5]

Agrega's whole operation is performed through an outsourcing system with Tradecom, a developer of solutions for electronic commerce in the Business-to-Business segment focused on developing, managing and operating horizontal and vertical, open and close marketplaces, providing Agrega a secure operation, access to state-of-the-art technology and know-how on the business. The alliance with Tradecom allowed Agrega

to reduce the time to become operative and to focus its attentions on its purchase systems.

#### 4. Financing B2B in Brazil

The need for sites in the Web that offer financing for working capital, projects, purchase of machinery, accounts receivables or any other type of enterprise that require credit, has led to the creation of portals that concentrate banks and financial institutions. The purpose of such portals is to offer, through the Internet, an easy and secure system for the several financial institutions to analyze credit requests and offer financing rates to companies by means of a single register file.

One of such portals is Multivalor ([www.multivalor.com.br](http://www.multivalor.com.br)). It offers companies free consultancy in credit operations to finance working capital, projects, purchase of machinery, accounts receivables, etc. to help them find the financing best suited for their reality.

Through Multivalor, a company can access 16 financial institutions with a single registration, receive credit proposals and choose the one which offers more advantages. As partners, the portal concentrates in a single site 14 banks and five small-credit institutions that provide the company their financing options and rates. The banks include BBV, BVA, Cacique, Citibank, Santander, and Emblema, among other. Among the institutions and companies that are clients of Multivalor, we can mention Unisys, João Fortes and Ipiranga.

The products offered include:

- Transfer of accounts receivable, where the Provider (Transferer) can transfer discounted receivables of large companies;

- Financing to clients in which any provider of equipments in general that wish to obtain financing to its clients can register such requests in Multivalor and access several financing products (CDC, Leasing, FINAME – Industrial Financing Program – and Working Capital), rating the operation with several banks at the same time.

The National Bank for Economic and Social Development (BNDES), a public company associated to the Ministry of Development, Industry and International Commerce, has recently made R\$ 300 million (around US\$ 100 million) available to an initiative for the creation of a credit card and online operations for small- and medium-sized companies. Bradesco, the second largest Brazilian bank; Visanet, company in charge of the relationship with commercial institutions affiliated to the Visa System; ABRAS, Brazilian Supermarket Association; and Visa do Brasil are its partners in this enterprise.[4]

The portal, which is being technically supported by Scopus, a company owned by Bradesco, and by Visanet for issues concerning the capture of credit data, was launched in late September of the current year. According to BNDES' Director of New Products, the initiative of creating a credit card financed by the entity to serve small

and medium companies was under study for at least 18 months. The consolidation of the Internet and electronic commerce have accelerated their decision to provide online credit.

The credit limit to the companies will be of R\$ 50 thousand per client. The BNDES card will be similar to any other credit card. Suppliers will receive the value of the sale 30 days after the operation and will be discounted a tax of 3%. The buying companies will have their limit studied – BNDES believes that the average limit will be around R\$ 20 thousand, not necessarily spent on a single purchase – and will pay the financing agent that issues the BNDES card in 12 fixed installments with monthly interests of around 2%.

Although trusting the electronic commerce initiative, BNDES estimates that over 90% of the transactions will be made by telephone. “The culture of online business still does not exist in this category of small- and medium-sized companies.”

In the first stage of the project, the beneficiaries will be supermarkets. The President of ABRAS, says there are potentially 16 thousand companies in this sector that might benefit from the BNDES card. They have difficulties obtaining credit and may now, by means of their suppliers or by Bradesco, have access to this credit line through the portal, which provides a simpler and less bureaucratic model.

BNDES expects, by October, to expand the portal and the credit card to sectors such as the shoe industry and especially that of components for production, health and education.

## 5. E-Government Solutions in Brazil

In May, 2000, the Brazilian government passed the Fiscal Responsibility Act.[7] It sets sanctions to Public Administrations that spend more than they collect, forcing them to manage their cash more efficiently and to show more transparency in their purchase procedures.

The use of the Internet will help the national, state and municipal governments to do so, making it easier to observe the restrictions set by the new Act.[15] The Internet also increases the competition among suppliers that take part in public biddings, apart from eliminating intermediates. With these gains in efficiency, an economy of up to 35% in the costs is expected, an amount that can be employed in benefits for the population.

Several public agencies are also already using the Web to make acquisitions, publish information on biddings, provide services and communicate with the population. Since, in some situations, the time needed to offer these services is limited, some of these sites are employing an ASP (Application Service Provider), which provides the development, customization, implementation and operation of the system, without requiring the agencies to invest in hardware, software or human resources.

An example of an e-Government solution is the one provided by Webb Negócios Online ([www.webb.com.br](http://www.webb.com.br)). This company provides a complete solution to public agencies that wish to relate with their commercial

partners and the society in general. This relationship is built by means of a special portal that allows publishing information and performing purchases quickly and efficiently.

The solution presented by Webb was named Governo@Webb. This solution is formatted according to the legislation on biddings and is hosted in a data-processing center with the highest security resources, assuring a fast implementation of the electronic-commerce project in public administration. By hiring the solution Governo@Webb, public agencies are free from the high investments for the construction and acquisition of an electronic-commerce platform.

The resources presented by the solution Governo@Webb include:

- Electronic catalogue: a tool that allows the public agency to, among other functionalities, register buyers and manage suppliers, add and approve purchase requests, control user access and register all of its acquisitions.

- Electronic auction market: a tool that allows the public agency to create and manage electronic auction markets, apart from obtaining minutes and registers of all acquisitions made.

- Message board: a tool that allows the public agency to publish news and information relative to public biddings, including calls, minutes and norms, as well as providing downloads and customized news via e-mail to assistant suppliers. The message board also includes an e-mail tool that allows suppliers to contact the Purchase Department of the public agency.

- Cataloguing and catalogue upload: the cataloguing service consists in creating a hierarchical navigation tree that better responds to the needs of the public agency. After the structure's design, the products are inserted in their respective categories.

- Registration of the approval workflow: a workflow is the purchase-approval flux within the public agency, built as a sequence of requests and approvals of the electronic catalogue. The use of the approval workflow assures total control over the acquisitions and the purchase limits of each user in the agency.

- Broad and detailed training offered by Webb to the main user in the public agency. The training seeks to present the main user his/her role in managing the purchase portal, making him/her able to carry out all management functions, such as registrations, user permissions, maintenance, etc.

- Technical support: this service offers the public agency support to clarify user doubts. For such, Webb provides a support center to solve technical doubts and deal with operational problems of the portal, offering attendants specialized in each solution. The support center can be accessed at any time by the main user of the public agency

Several Brazilian cities have already subscribed to this initiative, such as Campina Grande, in the state of Paraíba; Juiz de Fora, in Minas Gerais; Florianópolis, in Santa Catarina; and Jundiá, in São Paulo. In the case of

Campina Grande, the government has obtained, among other results, a reduction in the costs of internal procedures, due to the automation of administrative activities; a reduction in the time spent in purchases, such as using telephone, fax, and processing the requests; and uniform purchase guarantees within the established regulations.

## 6. Solutions of Private Companies in Brazil

Some of the largest corporations in the field of consumer goods, such as Pão de Açúcar, Procter & Gamble and Santista Alimentos, and means of production, such as Aventis CropScience (agribusiness) and GE Polymerland (plastics), are investing in their own sites while waiting for the consolidation of market portals (e-marketplaces) and the standardization of electronic data transmission technology, which should congregate several suppliers and buyers from specific segments, obtaining cost reduction and an increase in supply-chain efficacy.

Grupo Pão de Açúcar is a Brazilian retail market leader, with 443 stores in 11 Brazilian states. In February 2000, it launched pd@net, a Business-to-Business portal for suppliers of the group. Their strategy to attract users focused on small and medium suppliers in the state of São Paulo, which represent 80% of Pão de Açúcar's purchases. Today, 97.4% of the group's purchases to its 2,500 suppliers in São Paulo are made through the portal. The most significant results include a reduction in the time spent by the purchaser to make the order: it took an average of 30 minutes by telephone, but only 10 minutes through the Internet. This represents a monthly economy of over 6,000 working hours. Time was also saved in the verification of receipts: before, it was done in 5 minutes; now, in 1 minute. Apart from electronically exchanging all information relative to the purchase procedures, pd@net has brought other functionalities, such as access to information on the performance of each supplier's products in each of the group's stores. Thus, if the sales of a given product are not fulfilling the expectations, the supplier can know this in real time and change its strategy for that store. By the end of 2001, Pão de Açúcar had finished the implementation of the pd@net system, allowing 6,000 suppliers to converge into it.[3]

Since September 2001, the Pão de Açúcar group is coordinating, together with the French group Casino and the Dutch group Royal Ahold, the Latin-American implementation of Worldwide Retail Exchange (WWRE), the largest electronic marketplace devoted to the development of collaborative commerce and supplier relationship.

Another example is the sales portal launched by Procter & Gamble, owner of popular brands in several segments (Ariel, Pampers, Hipoglós, among others) supplied by means of around 20 distributors to almost 300 thousand small- and medium-sized points of sale, and 300 large direct clients. The portal employs technology already globally adopted by the group and represents an investment, in the Brazilian division, of

US\$ 250 thousand, being directed to scattered clients. All clients of the company will be able to access the portal's contents, but the sales policies by means of distributors will be maintained, as well as the EDI (Electronic Data Interchange) for the large clients who do not wish to migrate to the new solution. According to the Logistics and IT Director of Procter & Gamble do Brasil, the portal is a channel for relationship and communication, as well as a low-cost, good-performance option for small and medium retailers to integrate in electronic commerce, reducing supply-chain costs.[16]

The company expects to obtain an economy in the sales procedures of R\$ 1 million per year as of 2002, having commercialized around 35% of the total volume via the Internet by the end of the year 2001.

A third example of a successful solution is the portal of Santista Alimentos, one of the largest food companies in Brazil. Santista Alimentos is market leader in margarines and cake mixtures, wheat importing and milling, and the production of flours for domestic, industrial and bakery purposes. It also has leading positions in pastas, mayonnaises, beverages and desserts. Its portal was developed to replace EDI in its communication with the approximately 90 transporters employed by the company. The first idea was to use the Web EDI through the same VAN (Virtual Area Network) that provided the management. Due to the high cost of the VAN and the need to provide support to the applications used by the transporters, the company opted for developing its own solution. All the actions were reproduced in the portal without any additional cost, allowing the integration of even the smallest transporters. Today, all transporters are using the portal.[16]

The good results with the transporters made the company move to the second step: integrating, through the portal, the 28 distributors that used to make their orders by fax. This was the only section that required integration, since the company's sales force was already automated by means of palm tops connected to the internal system. The distributors, on the other hand, had to undergo troublesome procedures to insert their orders in the system, which represented high costs and errors. Soon, the company will join the automation and integration system of the Bunge group, which congregates, apart from Santista, other large companies in the food sector, such as Ceval and Seara.

## 7. E-Marketplaces in Brazil

The marketplace offer is divided into environments based on product cataloguing tools and auction markets. While the electronic cataloguing environment provides a standardized list of supplier products and commercial conditions so that buyers can perform quotations and make orders, the auction markets are based on an electronic sales negotiation tool which allows total dynamism between sellers and buyers in the negotiation of a single type of product or service. These auction markets are developed according to a market opportunity or demand. An important example are the Energy

Marketplaces, developed during the electric-energy rationing, occurred between May 2001 and February 2002. These marketplaces consisted of a compensation system for electric-energy consumption goals created to support small, middle and large companies during the energy crisis period. By means of the Energy Marketplaces, thousands of companies were able to commercialize their energy quotas through electronic auctions.

The most expressive examples of Brazilian e-marketplaces include Mercado Eletrônico, the second largest Brazilian B2B portal in volume of transactions; Genexis, a portal that integrates all companies and service providers related to the health sector; and Webb Negócios Online.[12]

Mercado Eletrônico ([www.me.com.br](http://www.me.com.br)), created in 1994, was the first Business-to-Business portal that offered purchase solutions through electronic media to medium- and large-sized companies. A pioneer and leader in e-procurement via EDI (Electronic Data Interchange) in Brazil, Mercado Eletrônico has recently received capital to take its operations and contents to the Internet, provided by the GP Investimentos group, an investment corporation founded in 1993 by Companhia Cervejaria Brahma (now AmBev), Banco de Investimentos Garantia (now CSFB Garantia) and by the investment fund CVC/Opportunity, an association of the banks Opportunity and Citibank operating since 1997, one of the largest private funds in Brazil.

Mercado Eletrônico is one of the leading companies in business volume in Latin America. The portal promotes 17 thousand daily transactions, connecting around 300 buyers to 30 thousand registered suppliers. It now operates also in Latin America, by means of a partnership with the portal Senegocia.com, one of the leader B2B companies in Latin America. Senegocia started operating in April 2000, and today counts with over 10 thousand companies, among buyers and suppliers. Senegocia is installed in Argentina, Peru, Mexico and Brazil.

Mercado Eletrônico has a complete commercial-information management system, with solutions integrated to the ERP (Enterprise Resource Planning) systems of companies that wish to maximize their purchasing efficiency. This allows the company to define system parameters, quotation format and report generation, also operating as a CSP (Commerce Service Provider), offering its transaction platform for quotations and request by its clients. Mercado Eletrônico also provides an access option by means of the Web portal, without the need for local adaptation or implementation.

The Genexis portal is the result of a fusion between SSI, a company associated to the e-procurement field, with six years of experience capturing requests by distributors and making connections with laboratories, and Healthlink, a health portal that relates health operators and registered doctors. The portal integrates all companies in the health sector, such as manufacturers, distributors, retailers and hospitals, as well as service providers, such as labs, doctors, etc. Through the portal, the professionals can execute all transactions, accessing

information, buying and selling products and materials, performing online procurement quotations, and processing documents and refunds.[17]

Genexis is divided in two segments: Health Products, which comprehends laboratories, distributors and hospitals, among others, and is the responsibility of the Genexis company, and Health Services, composed by health plans, clinics and medical assistance, responsibility of Healthlink. The company was created in 1994, offering connectivity to wholesalers by means of the EDI system. In 1997, it started the Internet operation and, in 1998, electronic commerce. Currently, Genexis acts in 124 active points of sale in Brazil.

The Energy Marketplaces, developed during the energy-rationing period consisted of a compensation system for electric-energy consumption goals. By means of the Energy Marketplaces, thousands of companies were able to commercialize their energy quotas through electronic auctions operated by Webb Negócios Online. Webb implemented and operated Energy Marketplaces in five Brazilian states, together with concessionaries Cemig, Light, Celg and Sistema Cataguazes-Leopoldina (CFLCL, Energipe, Saelpa, Celb, Cenf).[18]

The Energy Marketplaces have effectively contributed for a better distribution of electric energy consumption, providing great help to the means of production of companies of all sizes and several segments. The success of this initiative can be observed in the results obtained: 1,600 registered companies, 1,300 electronic auctions operated, and 14 million Kwh/month traded.

Although the energy rationing is over, the Energy Marketplaces will resume their operation, since the Brazilian electric-energy market is undergoing deep structural change and it has been defined that the energy of national and state public plants that will be free from initial contracts as of 2003 will have to be commercialized by means of public auctions.

## 8. Conclusion

This paper was meant to present a brief report on the development of Business-to-Business in Brazil. Similarly to what is occurring in more industrialized countries, this segment of electronic commerce is the one presenting the highest growth rate in our country. Today, Brazil is ahead of the other Latin-American nations; however, the number of companies that have adhered to electronic commerce is still low.

The support provided by the Brazilian government in the creation of the Electronic Commerce Electronic Committee, in a joint effort with the private sector, has clearly shown the importance given to this new segment of commerce. The actions of this Committee in perfecting norms and regulations, as well as technical standards, will be crucial for the expansion of Business-to-Business among Brazilian companies.

Companies that use Business-to-Business have not only managed to reduce their costs, but have also demonstrated more efficiency in their operations. Examples such as Agregã, a portal jointly formed by

AmBev and Souza Cruz, and that of the Pão de Açúcar group, clearly express the benefits that can be gathered by companies with the introduction of Business-to-Business in their activities.

This work have also shown that the governmental sector can obtain great benefits with the implementation of Business-to-Business. The use of one of its tools, the electronic catalogue, allows a better management of public accounts, providing more transparency in the purchase procedures and yielding a reduction of costs with personnel and communications.

Financing policies to Business-to-Business have also progressed significantly. Recently, the National Bank for Economic and Social Development, BNDES, has launched a credit card destined to small- and medium-sized companies supported by Bradesco, Visanet, Visa do Brasil and the Brazilian Supermarket Association.

Finally, this work has outlined the development of e-marketplaces, created as a consequence of market opportunities or demands, and their contribution to the expansion of business opportunities to suppliers and price reduction for the acquisition of goods to buyers. Examples of successful e-marketplaces, such as Mercado Eletrônico and the Energy Marketplaces, developed by Webb Negócios Online, demonstrate the benefits of e-marketplaces.

New creative solutions, adapted to the conditions of the Brazilian economy, appear every day, demonstrating the immense possibilities of Business-to-Business. Thus, we can conclude our work stating that this new form of corporate business has come to stay.

## References

- [1] *Business News America*. "Para Analista da Jupiter, Alianças e Aquisições Salvarão B2Bs Independentes", May 16, 2001.
- [2] Colcher R. "Brazil Still an Emerging E-Business Market, but Leader of Latin America", *IdeaByte*, June 11, 2002.
- [3] Companhia Brasileira de Distribuição. Relatório Anual 2001 [1] *IDG Now!* "59% dos Executivos Continuam Apostando no B2B", April 04, 2001.
- [4] *Computerworld*. "BNDES Adota o Comércio Eletrônico para Pequenas Empresas", September 19, 2002.
- [5] Conde, L. "Como a Web Pode Impactar a Gestão de Compras de MRO nas Empresas", *Agrega*, December 07, 2001  
(<http://www.agrega.com.br/artigos/default.asp?noticia=52>)
- [6] *Gazeta Mercantil*. "Portal de e-Business Une Ambev e Souza Cruz", December 18, 2001.
- [7] IBAM. "Comentários à Lei de Responsabilidade Fiscal", April, 2001, p. 3.
- [8] *IDG Now!* "59% das Empresas Brasileiras Estão na Web", August 09, 2001.
- [9] *IDG Now!*, "59% dos executivos continuam apostando no B2B", 04/ 04/ 2001
- [10] *IDG Now!* "B2B Mundial Crescerá 83% em 2001, diz IDC", October 17, 2001.
- [11] *IDG Now!* "Mais de 35% dos Gastos de B2B nos EUA Serão Online", September 27, 2001.
- [12] *Info*. "Os Donos do e-Commerce", May, 2002.
- [13] *Internet Business*. "Compradores Resistem a Portais B2B", April, 2001.
- [14] *Jornal do Commercio*. "Bom Momento para se Investir no e-Commerce", October 24, 2001.
- [15] Mayon, P. "Entrevista da CBN com Diretor da Webb Destaca Soluções de eGoverno", May 02, 2002 ([http://www.webb.com.br/noticias/novidades\\_webb/maio2002/02052002.htm](http://www.webb.com.br/noticias/novidades_webb/maio2002/02052002.htm)).
- [16] *Revista E-Commerce*. "O Longo Braço Digital", May, 2001.
- [17] *Valor Online*. "Novo Site Investe US\$ 25 milhões", December, 2000  
([http://www.genexis.com.br/institucional/clipping\\_2.html](http://www.genexis.com.br/institucional/clipping_2.html))
- [18] Webb Negócios Online. "Bolsas de Energia", (<http://www.webb.com.br/webbmarketplace/bolsas/energia/index.htm>).

# The Asian Difference in B2B E-Marketplace

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## Abstract

This study contends that the low rate of e-marketplace acceptance by Asian firms cannot be fully understood without analyzing the context within which technology is exploited. Current IOS (Inter-Organizational Systems) studies emphasize the removal of barriers to e-marketplace acceptance in relation to technological, organizational, and inter-organizational factors. However, the contextual influences of IOS are largely ignored. We highlight three levels of contextual influences – structural, national/regional, and socio-cultural – that shape the adopters' expectation of e-marketplace applications in three Asian regions (India, Taiwan, and China). Our study formulates arguments that attempt to flesh out the constraint of context as one of the most significant, but often neglected, dimensions of e-marketplace acceptance.

## 1. Introduction

There has been a rising interest in using e-marketplaces (electronic marketplaces) to enable closer B2B (Business-to-Business) collaboration. Nonetheless, the widespread e-marketplaces have not been adopted readily into companies in Asia. The study is an initial attempt to explore the reasons for the non-acceptance of e-marketplace in inter-organizational contexts situated in a different cultural setting.

An e-marketplace can be defined as a platform that uses the Internet to enable buyers and sellers to conduct inter-firm trading [3]. There are three generic forms of e-marketplace [8]: (1) industry-based (i.e. vertical) or product-oriented (i.e. horizontal) e-marketplaces backed by founding members, (2) private e-marketplaces, usually formed by a single buyer or supplier, to link up their business partners, and (3) public e-marketplaces that are set up by neutral third party, known as "Net Market Makers", to facilitate business transactions for their participants, with their revenue coming from subscriptions and transaction-based fees.

Although e-marketplaces can reduce transaction costs, improve process efficiency, and enable virtual collaboration among partners, market analysts have reported that the majority of them have either closed down or are facing difficulties in attracting buyers and suppliers [21]. Recent reports, though somewhat limited, have shown that sole reliance on the application of the US business models in Asia is a recipe for failure [4][8][19][23].

The present study seeks to highlight the limitations of

a technical-economic view of e-marketplace adoption [2][18]. It explains how contextual forces that have shaped Asian businesses play an important role in the adoption of e-marketplaces.

## 2. Barriers to the acceptance of e-Marketplaces

Three broad categories of adoption barriers have been identified in current literature: technological, organizational, and inter-organizational [11][16][25]. Technological barriers are concern with technological complexity. For example, the adoption of e-marketplaces requires effective the use of external network technologies. As security technology is still at an embryonic stage, transaction risks are endemic. Other major technological challenges include system integration, software migration, data conversion, and the compatibility of hardware and software between partners [19]. For most adopters of e-marketplace, the sheer complexity of technological problems can prevent them from accepting the new technology.

A common intra-organizational inhibitor is the lack of sufficient training and education in the technologies involved. Furthermore, the adoption of e-marketplaces often requires companies to redesign their internal business processes, if the technologies are to be used effectively [5][20]. But this is not easy, especially when operations are deeply bound by different technologies in different organizations. Lee and Clark [20], for example, explore two failed attempts to introduce electronic exchanges into the potted plants and fresh meat sectors. They explain that the ineffective integration of product and transaction flow, which caused inconsistent purchasing quality, was a major cause of such failure. Clark and Stoddard [5] also point out that a key adoption barrier is to exchange marketplace data among organizations in transaction and replenishment processes. They explain that new technologies break old routines and the keepers of the old routines often resist, usually because they have to master new socio-technical skills that are imperfectly realized and barely understood in relation to existing ways of doing things.

Inter-organizational barriers often arise from the factor of power and trust [1][11]. For example, in a case study of Ford Motors [27], the company was in a strong position to instigate the use of electronic procurement with its suppliers. However, its attempt to exercise coercive power over suppliers (e.g. through the transfer of

investment costs to them) resulted in adopters' resistance. Trust factor is another barrier. There are two aspects of trust: competence trust, which is concerned with a partner's ability to perform according to expectations, and intentional trust, which refers to a partner's intention not to defect from its collaborative party [24]. For instance, Hart and Saunders [11] analyze a retail company and show that asymmetry of product information-sharing among partners may lead to distrust of the market makers' competence, leading to adopters' abortion from the e-marketplace. Allen et al. [1] investigate an unproductive e-marketplace called TransLease (designed for automobile insurance) and explain how mutual distrust in intention arose among buyers (lease firms) and sellers (repair agents), stemming from both parties' conflicting goals. From a cognitive perspective, Barrett [4] explains why adopters (brokers and underwriters) feared the uncertainty and job security brought about by the London Insurance Market, where distrust emerged as a result of adopters' negative interpretations of the technology's intention.

One important matter overlooked in current investigations is the role of context, not only as a cause of inaction but also as a key factor involved in the production of barriers [2]. In this view, barriers to the adoption of e-marketplaces may derive from institutional contexts, including structural, national/regional, and socio-cultural aspects (categories which are not mutually exclusive).

Structural constraints are key adoption barriers in the adoption of e-marketplaces, especially in many developing countries in Asia. For example, the ineffective infrastructure in telecommunications, financial systems (e.g. electronic payment systems), legal and regulatory systems (e.g. taxation), and the logistics systems (e.g. transportation) will inhibit the adoption of e-marketplaces [21].

Barriers to e-marketplace applications cannot be fully appreciated without also understanding the challenges that stem from national and regional contexts. This point is underscored by a study that examines the adoption of e-marketplaces in Cyprus [2]. As the basis for a national agenda to transform small-sized enterprises into flexible, specialized organizations, the Cyprus government initiated a major industry restructuring. Avgerou [2] examined the introduction of three consortium-based e-marketplaces in the furniture industry. In spite of the existence of sufficient technological and financial supports, the furniture manufacturers aborted the use of these systems. As such, this failure should be seen in broader national and regional contexts.

Historically, Cypriot firms had moved from mass production to mass customization in order to pursue niche market, using the strategy of flexible specialization. However, the e-marketplace had been designed for volume transactions (mass production). Using it in the context of complex transactions (mass customization) was inconvenient. Moreover, the entrepreneurs were family owners, who understood their craft, suppliers and markets well, but were not at ease with e-marketplace. Hence, it

was not possible for them to incorporate such systems in their existing operations. The owners neither had the skills to incorporate the system nor did they have the desire to make the changes. They would have had to reconfigure their customary business models and introduce professional managers into most of the family-owned businesses. This would mean asking entrepreneurs to relinquish power and undertake radical organizational transformation. These developments were all contrary to the entrepreneurs' expectations in adopting e-marketplaces, and the project ultimately failed.

The third impact of socio-cultural constraints on adoption failures may be illustrated in the case of the failure of SPRINTEL [18]. SPRINTEL was an e-marketplace designed for the textile trading community in Prato (near Florence, Italy). In spite of the provision of sound technical and economic solutions, Prato's traders did not accept the e-marketplace. In contrary, it developed distrust among traders. The distrust, which became the basis for resistance to the system, was not rooted in technical failures of the system but from Prato merchants' socio-cultural concerns.

Historically, Prato's traders had established an industry network formed by business communities that trusted each other. Their social relations were embedded within economic activities. Traders saw little value in having exchange systems that enabled faster and more reliable transactions. Prato's traders also preferred "high-context" communications (e.g. face-to-face encounters with rich body expression), and were worried that an e-marketplace might disable these preferred social interactions. Additionally, we need to appreciate that these Prato traders did not regard maximization of profit as the only purpose of business; rather, people participated in business as one important way of socialization. Moreover, these Prato traders were concerned that an e-marketplace might reveal the existence of redundant inventories, which, in their cultural context, would mean a public confession of business incompetence. Participation in a more transparent system would mean that not only other traders would know one's affairs; so would the tax authorities. The traders were worried about the impact of disclosing information about their *sommerso* (underground economy activities), such as tax evasion, in a cultural context where tax payment is seen as fair game.

While technology is typically thought of as a thing, as an entity, it is evident that for the traders of Prato it was a social relationship. The SPRINTEL study highlights the fact that technology acceptance is not based merely on technical excellence and economic gains. People do not communicate the meaning that they attribute to a technology individually, but collectively, in a common sense making. The SPRINTEL case clearly reveals that distrust resulted from the technology being interpreted negatively as a result of the socio-cultural context into which it was introduced.

Research into contextual influences offers a useful lens when examining technology adoption that involves cross-cultural transfer. Adopters' social expectations of

technology use are shaped by the context within which they normally operate. When researchers investigate the adoption of e-marketplaces in differing social, cultural, and geographical contexts, the conception of technology as a variable whose inherent capabilities premise its adoption becomes quite limited. The constraining role of context is significant in understanding the origins of resistance to technology adoption within organizations.

### 3. Research Methods

Our research took place in Commerce One (one of the leading vendors of e-marketplaces). The company had realized that their Asia headquarters were facing a major adoption challenge that had not been foreseen in terms of the marketing strategy adopted from the US headquarters. The US strategy promoted the benefit of cost reduction and process efficiency, but it did not seem to work in Asia. In spite of the company's marketing efforts, the level of acceptance remained low. With the help of the company, our pilot study involved three of their country portals (disguised name) – IndiaMarket (in India), TaiwanMarket (in Taiwan), and ChinaMarket (in China). The first author interviewed more than 50 key participants over a 16-month period (from January 2001 to April 2002). The data were mainly based on personal interviews with technology providers and adopters. Extensive field notes were taken during and immediately after these interviews. In this paper we report our preliminary findings concerning the contextual constraints that persist in e-marketplace adoption in Asia.

The approach to data analysis that we adopted is one that relies upon the contextualist perspectives [2] and cross-cultural transfer of technology [18]. An important analytical aim is to examine how the different contexts of solution providers and potential adopter influence the adopter's expectation of e-marketplace use.

Three theoretical angles were used to guide our field interviews and investigate the non-acceptance reasons in each site. In IndiaMarket, we examined the structural context and highlighted the impact of India's complex taxation systems on e-marketplace adoption. In TaiwanMarket, we turned to the conditions shaped by the national and regional contexts. We explored how industry migration in Taiwan had gradually shifted Taiwanese adopters' expectations of e-marketplaces. In ChinaMarket, we explored the extent to which the theory of Chinese Relationalism informed a different cultural pattern of business practice, in contrast to Western (Anglo-American) models of commerce. Understanding the extent to which such a pattern constitutes a different frame offers valuable explanation of the underlying resistance to e-marketplace systems in the Chinese trading community.

The three stakeholders in the e-marketplace studied consisted of buyers, sellers, and NMMs (Net Market Makers, see Figure 1), the latter as information intermediary. NMMs provide two important services to participating members. First, they offer a technological

platform for both buyers and sellers to conduct product search, procurement, auction and transaction. Secondly, NMMs offer physical value-added services to fulfill business transactions, including product content management, business intelligence, financial payment, logistics, and shipping inspection. To sustain revenue, NMMs normally charge buyers and sellers a subscription or transaction fee for their services. Alternatively, other NMMs assist adopters in installing their own proprietary e-marketplace systems by charging consulting and software licensing fees. The common goal of NMMs is to achieve a critical mass of adopters so that they can collect enough subscription fees to sustain their services. To achieve this, a common adoption strategy is to recruit large buyers and attract the associated sellers. The value proposition for buyers, offered by these three NMMs, is to access more sellers (suppliers), gain best price advantage and streamline supply chain processes.

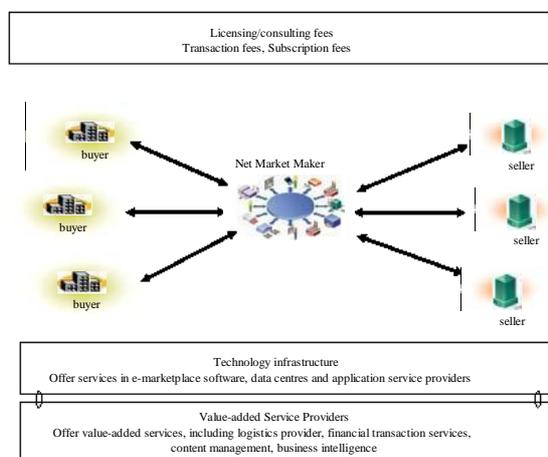


Figure 1. The Function of a Net Market Maker

NMMs had a crucial role to play as brokers, in whose interests the spread of adoption would be hastened. Yet, upon the completion of our fieldwork, most adopters had not fully adopted e-marketplace solutions, despite the actions of both Commerce One and the NMMs as providers of solutions that involved the adoption of the e-spaces on sale. The potential adopters were less concerned with technological problems, process integration, and inter-organizational trust, as emphasized in the IOS literature. Although adopters reported common constraints imposed by the public infrastructure (such as poor telecommunications and electricity provision), they seemed to worry more about the crises arising from their local contexts. We came to recognize the importance of seeing these adopters' resistance to e-marketplaces as something that required careful consideration of the influence of contextual conditions. A summary of the three cases is shown in Table 1.

Table 1. Description of Cases

	IndiaMarket	TaiwanMarket	ChinaMarket
Background	A project seeking to business opportunities in light of Indian government's IT Bill.	A quasi-government project helping Taiwanese manufacturers to integrate supply chains with MNC.	A government initiative to prepare for WTO entry.
Time of launch	May 2001	March 2001	May 2000
Technological Platform	Commerce One's e-marketplace systems: e-procurement, e-auction, and order management.		
Value added services	Change management, telecom infrastructure, logistics, Credit-rating information services, business surveillance, pre-shipment inspections, and financial payment.	Data center, hosting services, technology integration, financial transactions, business intelligence, product catalogue management.	Financial transactions, technological infrastructure, logistics, and Digital certification.
Adoption strategy	Buyer-led adoption: targeted at 50 major buyers in India.	Buyer-led adoption: leverage on a government initiated project for computer industry; aiming to recruit key buyers as shareholders.	Buyer-led adoption, government initiated: focus on state-owned exporting companies in ten key industries.
Focus of analysis: contextual constraints	Structural constraints (especially taxation issue).	National/regional contexts (Industry migration).	Socio-cultural context (Guanxi networks).

#### 4. Findings: Unearth the Contextual Influences

##### 4.1 IndiaMarket case: Taxation Dynamics

Not until the late 1980s, when the government realized the futility of shutting India off from the rest of the world and started to liberalize the economy, by opening up the Indian business community to international competition. Faced with this challenge, Indian businesses began to adopt international trade practices. The federal government also introduced an Information Technology Bill in June 2000 with the aim of integrating the fragmented markets that existed among the 30 states comprising the federation, in order to attract foreign direct investment.

By late 2000, Indian's e-commerce appeared to be promising. Large enterprises, such as TELCO, one of the flagship TATA companies, began to sell scrap machinery and manufacturing surplus to partners through e-marketplaces. Increasingly, MICO (a BOSCH subsidiary) also sold fuel injection pump inventory to its

partners over the Internet. Nonetheless, most enterprises still could not afford the cost of either setting up e-marketplaces.

In May 2001 IndiaMarket was incorporated to provide intermediary information services to Indian business communities. It commenced with an early success in the form of the introduction of an e-procurement solution for DCM Shriram Consolidated Ltd., an e-auction for Hindalco (India's largest aluminum producer), and an e-marketplace for Tata International. IndiaMarket's strategic vision was to help Indian enterprises shift their trading relationships to e-marketplaces.

In terms of structural constraints, the lack of sound infrastructure was still the primary barrier to the adoption of IndiaMarket. These explicit constraints included poor infrastructure in financial, logistic, legal and other services in India. In terms of financial infrastructure, Indian adopters reported that most areas still had no efficient inter-bank transaction systems. Issuing a letter of credit could involve as many as seven banks and government agencies. There were also no monitoring systems to evaluate suppliers' credit risks. In terms of logistics infrastructure, there were still few established third party logistics providers. It was difficult to keep track of consignments as well as to maintain reasonable control of traffic in cities. In terms of legal infrastructure, the overburdened legal system presented numerous difficulties when a legal sanction was needed against defaulting debtors. The lengthy legal processes alerted buyers to the problems of transacting with suppliers lacking credentials. Finally, because of poor telecommunications infrastructure, constant power breakdowns were a part of life. The demand for electricity outstripped supply in many industrial cities such as New Delhi and Bangalore.

These were the explicit structural constraints. However, there was one implicit structural constraint that was, perhaps the most serious threat to e-marketplace adoption: India's taxation systems. Adopters doubt whether an e-marketplace can be localized easily to accommodate the complexity of governmental taxation variation. One example of this variation is in the way in which the central and state governments levy taxes. The federal government is empowered to levy central taxes, which includes sales, custom and service taxes. The states levy sales taxes and excise duty based on the value of commodities. Another impediment is the "octroi", a tax on the entry of goods into a local area for consumption, use or sale. The federal government also allows the states to levy taxes on inter-state sales. The effect is the creation, within each state, of a tariff zone where taxes are levied on exports to other states. Even with the ceiling on the inter-state sales tax, the cascading nature of the tax system produces a situation where effective tax rates are uncertain, as tax costs vary with the process of the goods sold.

Consider the following example of an automobile parts manufacturer in New Delhi. Based in state A, when a sales forecast plan was proposed, the company had to pay pre-sales taxes to the government of state A. The company

also had to pay turnover taxes on a fiscal year basis. If the company transported products to state B, it had to pay excise taxes to the government of that state. Any components sold there would also be subjected by the local government of state B to local sales taxes, service taxes, and turnover taxes. The complexity was compounded by the constant variation of the tax structure, in terms of both the rate of tax and the range of taxable items. With components consisting of several hundred parts, putting the mathematics of taxation into a computer program would itself be a very difficult task. Moreover, one should also appreciate that Indian businessmen are always worried about exposure of their various tax-avoidance tactics (this is similar to Prato's case).

The use of e-marketplaces runs against India traders' social expectation in response to the business conventions shaped by those structural conditions. The reasons for non-acceptance of the technology can thus be understood.

#### 4.2 TaiwanMarket: Industry Migration

Before 1998, a hostile political relationship had severely handicapped formal business collaboration. The softening of those relationships encouraged Taiwanese enterprises to extend their manufacturing bases to the major cities in China. Adding to this industry migration was the strategic transfer by multi-national corporations (MNCs) of their regional headquarters to China. For most Taiwanese firms, this could involve the migration of their whole supply chain to China. In the computer industry, for example, Compaq alone procured about US\$85 billions in Taiwan in 2000. If Taiwanese firms did not move with their key buyers, they would soon put their long-established business relationship into jeopardy.

In March 2001, a Taiwanese quasi-government agent, Institute for Information Industry (III) decided to help the computer industry build an e-marketplace to link up buyers (Compaq was the first test site) and suppliers (Taiwanese firms). The purpose was to maintain close collaboration with these key buyers while assisting Taiwanese suppliers to streamline their supply chain operations.

The transformation from domestic to regional operation presented a great challenge to Taiwanese firms. The migration involved not only moving factories and people to China but also managing product designs, strategic sourcing, and supply chain activities across the different regions of China. For example, the relocation of a computer notebook manufacturer required product design engineers in Taiwan to work collaboratively with manufacturing sites in Shanghai and Xiamen. The company often had to hold co-location meetings in order to make sure that products were designed to comply with specification and manufacturability requirements. Face-to-face discussions and conference calls were perceived as trustworthy methods of communication. Moreover, the company had to extend its supplier bases to China, which meant that it had to replace some of its Taiwanese tier three suppliers and to source local suppliers in China for reasons of cost advantage.

The context of industry migration helps us to understand why these Taiwanese firms were not interested in e-marketplaces (presented in the US model) that mainly offered the functions of product search, electronic procurement, and auction. In the context of industry migration, Taiwanese firms' managerial attention was more concerned with collaborative design, strategic sourcing, supply chain management, customer retention, and regional operation. The e-marketplace did not match this expectation and was considered to be of little use.

#### 4.3 ChinaMarket: Chinese Relationalism

In 2000, China faced the challenge of entering the WTO (World Trade Organization). The government sought to transform key national enterprises (such as steel industry) in order to prepare them for the transition from the traditional planned economy to a market economy. To achieve this end, the government agent (The Development Research Center of The State Council) initially planned to construct an unprecedented industrial park, big enough to accommodate ten key business sectors. International traders could visit this industrial park, search products, identify potential business partners, and achieve one-stop shopping.

The establishment of such an industrial park required enormous investments, in terms of money, land, and other resources. Additionally, state planners envisaged that upon completion such an industrial park could result in major traffic problems, the possibility of an increase in criminality through concentrating major commerce, as well as an increased demand for enhanced public services. Thus, from the state perspective, the risks associated with such a project were high. Building a vast incubator on such a scale would also have major socio-spatial implications for the host region.

Eventually, the planners conceived the concept of a virtual business park, incorporated as ChinaMarket.com in March 2000, with the aim of enabling the idea of an e-WTO response (i.e. using electronic means to respond to the WTO challenge). An American model of commerce guided its design.

The launch was not entirely successful. Although ChinaMarket consultants emphasized the benefits of cost reduction, process efficiency, and business opportunities (especially access to more international buyers), adopters still expressed difficulties in relating the systems to their existing business practices. To appreciate this dilemma, we need to understand the socio-cultural context in which the Chinese conduct their business activity. This involves Guanxi (relationship) networks, high-context communication, and in-group favoritism [13][22][15].

In the American model of commerce [18], the purpose of business emphasizes optimal economic gains achievable under a model of rational assumptions (this generalization is only for illustration; in fact, American businessmen also emphasize relationship-based trade, see [9]). Cost and efficiency are two important criteria of this model. For example, buyers are conceived as agents wishing to invest in technology in order to reduce search

costs (by identifying suppliers more quickly), transaction costs (by increasing process efficiency), and labor costs. Buyers will readily replace suppliers should they find preferable substitutes that can offer better product quality at a lower price. If there are non-repudiation issues, buyers and suppliers can settle their disputes through legal assistance.

Chinese traders operate with a different approach to business, using a different frame of assumptions (note: again, the generalization is for explanatory purpose; it will be problematic when different regions of Chinese traders are considered). Because contemporary China has not yet established a sound market and legal infrastructure, entrepreneurship often follows a culturally conventional approach of building business from family-based networks. In this context, since most non-repudiation issues and other trade disputes cannot be settled easily within the Chinese legal framework, the selection of business partners involves high risks, especially where non-family members are involved. Thus, the tendency is to keep business, as much as possible, within the family or close kin relations. Reducing business risks becomes a prime objective of the formation of any business partnership. To evaluate the trustworthiness of their trading partners, the Chinese often employ a set of implicit, but specific, strategies.

First, Guanxi networks are used widely to extend personal (family-based) relationships to business relationships. Chinese businessmen generally consider three types of network: family, friends and strangers [7] [15]. These three types of network represent how well a person can trust their business partners. For example, Chinese traders often trace the genealogy of their potential partners to see if there is any family linkage. This does not mean that they will necessarily trust their partners as long as a kinship link is found. The purpose will be to use family relatedness as a way of tracing the partners' background, in order to learn about their credit, past record of business practice, and personal integrity. Forming business partnerships, for most Chinese traders, is like establishing life-long friendships. For Chinese traders, Guanxi is not just about forming business relationships but also about forming personal friendships, with the purpose of reducing business risks.

Second, having these networks as a method of checking personal credentials is not enough. Chinese traders also develop an implicit method for evaluating personal integrity, reducible to one ultimate question: how can I trust this person with my business? Chinese traders employ tacit communication protocols, known as high-context communication: messages are comparatively terse in words, but rich in meaning [22].

For Chinese traders, metaphors are frequently used as a means for high-context communication. This has at least three purposes: to avoid direct conflicts, to test personal integrity and intelligence, and to communicate meaning with maximum ambiguity (so no one has to promise anything and rush into partnerships). Additionally, in order to assess trustworthiness it is more important to

observe the other person's social behavior than to consider what the person says rhetorically.

Third, building business partnerships in this Guanxi-based context breeds favoritism. However, one must not be tempted to attribute negative meanings (such as bribery) to favoritism; otherwise, one may only see favoritism in terms of its face value. Favoritism is considered as an appropriate way to maintain existing Guanxi networks in Chinese business communities [14].

Understanding the socio-cultural context in Chinese business communities helps one appreciate its influence on the rate of acceptance of e-marketplaces. The introduction of e-marketplaces will inevitably threaten Chinese traders' existing ways of building and maintaining Guanxi networks. Identifying suppliers through a computer interface presumes that buyers can reasonably trust suppliers, but this assumption conflicts with the traditional Chinese Guanxi approach to assessing potential partners. Although Chinese traders could identify more promising suppliers by using an e-marketplace, they would also be hesitant to replace existing suppliers for fear of jeopardizing long-standing Guanxi networks.

Chinese adopters thus perceive the e-marketplace as an unsophisticated way to minimize business risks, especially without the fluid assistance gained by mobilizing their Guanxi networks. Additionally, for Chinese traders used to conducting businesses through human interactions, i.e. through the social processes normally used to make friends and gain recognition in business communities, the depersonalized system features were perceived as obstacles to a properly social business relation. For the Chinese, good business practice should involve assessing trusted persons through existing Guanxi networks, building business partnerships through personal relationships, and maintaining Guanxi through in-group favoritism and reciprocity. According to these assumptions, the e-marketplace based on technical-economic assumption seems to add little value, and is insensitive, to these Chinese adopters' social expectation of technology use.

## 5. Implications: The Significant Role of Context

A frequent comment suggested by adopters of these three e-marketplaces is that e-marketplaces seem to be an American management practice that does not fit easily with Asian contexts. But, why do they make such comments? Our study offers a contextualist explanation.

This research highlights three kinds of contextual influence on e-marketplace acceptance: the structural contexts, national/regional, and socio-cultural. First, the study of IndiaMarket supports Markus and Soh's [21] observations concerning the effect of structural conditions. Structural constraints, such as the lack of logistic, financial, educational, and legal infrastructures, can significantly influence the decision to accept technology. Particularly, such structural influences are often difficult to resolve within a short period of time, as they are deeply

embedded in political and economic systems within a country.

Second, our findings in the TaiwanMarket case resemble those in Avgerou's [2] study of the unsuccessful adoption of e-marketplace in Cyprus. The changing national/regional context redefines the role of information systems in business operations. Non-acceptance occurs because adopters cannot see the relevance of technology use in response to the challenge imposed by their specific national or regional context. For many such local contexts the customary business practice are of more salience than the efficient markets assumed elsewhere.

Third, ChinaMarket's case echoes SPRINTEL's failure in Italy [18]. Similar propositions are also supported by other research: for example, Martinsons and Westwood's [22] study of MIS adoption in Chinese enterprises, and Walsham and Sahay's [26] investigation of Geographical Information Systems in India.

Generally, Asian-based studies, such as Kendall et al.'s [17] survey of e-commerce adoption in Singapore, and Hempel and Kwong's [12] investigation of B2B e-commerce in China, overlook such contextual influences. Our aim in this study is to urge practitioners and researchers not to limit their evaluation to the technical-economic dimension of adoption problems, thereby failing to appreciate the more subtle aspect of contextual influence.

## 6. Conclusion

The three case studies offer an initial explanation of the adoption challenge of e-marketplace in three geographical regions in Asia. The analysis focuses on the embedded context for business activity rather than the technological features and organizational processes. We conclude that the resistance to e-marketplace was not limited to technological, organizational and inter-organizational impediments. In the three cases it is more important to understand the role of context in shaping adopters' expectation of technology use [10], which in turn led to non-acceptance. In this situation, adopters were unclear how an e-marketplace would add value to their businesses. Hence, if e-marketplace use is perceived as irrelevant to the expectation of the adopters – expectations shaped by contexts – the entire adoption effort may wither before technology has a chance to take root. Hence, effective adoption of technology depends on a consideration of how people's expectation of technology use is met in a given context. The lens of context adds a fruitful, alternative perspective in explaining and anticipating technology outcomes.

## References

[1] Allen, D. K., D. Colligan, A. Finnie, and T. Kern. "Trust, Power and Inter-Organizational Information Systems: the Case of the Electronic Trading Community TranLease." *Information Systems Journal*, 2000, 10, 21-40.

[2] Avgerou, C. "The Significance of Context in Information Systems and Organizational Change." *Information Systems*

*Journal*, 2001, 11, 43-63.

[3] Bakos, Y. "A Strategic Analysis of Electronic Marketplaces." *MIS Quarterly*, 1991, 15(3), 295-311.

[4] Barrett, M. I. "Challenges of EDI Adoption for Electronic Trading in the London Insurance Market." *European Journal of Information Systems*, 1999, 8(1), 1-15.

[5] Clark, T. H. and D. B. Stoddard. "Interorganizational Business Process Redesign: Merging Technological and Process Innovation." *Journal of Management Information Systems*, 1996, 13(2), 9-29.

[6] Dhawan, R. K., R. Mangaleswaran, A. Padhi, S. Sankhe, K. Schween, and P. Vaish. "The Asian Difference in B2B." *McKinsey Quarterly*, 2000, 4, 38-47.

[7] Farh, J. L., A. S. Tsui, K. Xin, and B. S. Cheng. "The Influence of Relational Demography and Guanxi: The Chinese Case." *Organization Science*, 1998, 9(4), 471-88.

[8] Goldman Sachs. "B2B E-Commerce/Internet: Asia Pacific Report." *Goldman Sachs Global Equity Research*, June 26, 2000.

[9] Grieff, A. "Cultural Beliefs and the Organization of Society: A Historical and Theoretical Reflection on Collectivistic and Individualistic Societies", *Journal of Political Economy*, 1994 102, 5, 912-950

[10] Griffith, T. L. "Technology Features As Triggers for Sensemaking." *Academy of Management Review* 24(3), 472-88.

[11] Hart, P. and C. Saunders. "Power and Trust: Critical Factors in the Adoption and Use of Electronic Data Interchange." *Information Systems Research*, 1997, 8, 23-42.

[12] Hempel, P. S. and Y. K. Kwong. "B2B E-Commerce in Emerging Economies: I-Mental.Com's Non-Ferrous Metals Exchange in China." *Journal of Strategic Information Systems*, 2001, 10, 335-55.

[13] Hofstede, G. and M. H. Bond. "The Confucian Connection: From Cultural Roots to Economic Growth." *Organizational Dynamics*, 1988, 16(4), 4-21.

[14] Hwang, K. K. "Face and Favour: The Chinese Power Game." *American Journal of Sociology*, 1987, 97:944-74.

[15] Hwang, K. K. "Chinese Relationalism: Theoretical Construction and Methodological Considerations." *Journal of the Theory of Social Behavior*, 2000, 30(2):155-78.

[16] Iacovou, Charalambos L., Izak Benbasat, and Albert S. Dexter. "Electronic Data Interchange and Small Organizations: Adoption and Impact of Technology." *MIS Quarterly*, 1995, 19(4), 465-85.

[17] Kendall, J. D., L. L. Tung, K. H. Chuan, C. Hong, D. Ng, and S. M. Tan. "Receptivity of Singapore's SMEs to Electronic Commerce Adoption." *Journal of Strategic Information Systems*, 2001, 10, 223-42.

[18] Kumar, K., H. G. van Dissel, and P. Bielli. "The Merchant of Prato -- Revisited: Toward a Third Rationality of Information Systems." *MIS Quarterly*, June 1998, 199-226.

[19] Laseter, Tim, Brian Long, and Chris Capers. "B2B Benchmarks the State of Electronic Exchanges." *Strategy & Business Fourth Quarter*, 2001, 1-11.

[20] Lee, H. G. and T. H. Clark. "Market Process Reengineering Through Electronic Market Systems: Opportunities and Challenges." *Journal of Management Information Systems*, 1996, 13(3), 113-37.

[21] Markus, M. L. and Christina Soh. "Structural Influences on Global E-Commerce Activity." *Journal of Global Information Management*, 2002, 10(1), 5-12.

- [22] Martinsons, M. G. and R. I. Westwood. "Management Information Systems in the Chinese Business Culture: An Exploratory Theory." *Information & Management*, 1997, 32, 215-28
- [23] Morgan Stanley Dean Witter. "The Asian B2B Report: A Value Explosion, But Who Gains?" Morgan Stanley Dean Witter Equity Research Asia Pacific November, 2000.
- [24] Nootboom, B., H. Berger, and N. G. Noorderhaven. "Effects of Trust and Governance on Relational Risk." *Academy of Management Journal*, 1997, 40(2), 308-38.
- [25] Soh, C., Siew-Kien Sia, and J. T. Yap. "Cultural Fits and Misfits: IS ERP a Universal Solution." *Communications of the ACM*, 2000, 43(4), 47-51.
- [26] Walsham, Geoff and Sundeep Sahay. "GIS for District-Level Administration in India: Problems and Opportunities." *MIS Quarterly*, 1999, 31(1), 39-65.
- [27] Webster, Juliet. "Networks of Collaboration or Conflict? Electronic Data Interchange and Power in the Supply Chain." *Journal of Strategic Information Systems*, 1995, 4(1), 31-42.

# Assessing Organizational Culture Difference between E-Commerce Companies and the Traditional Ones: A Measurement Invariance Perspective

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## Abstract

Organizational culture is an important factor in organization development process. This paper explores the culture issue in the new technology age. Adopting Ruppel's new culture framework developed from traditional perspective on culture the paper tested the culture difference between organization with intranet and without intranet. Using Confirmatory Factor Analysis method with Lisrel the paper explored the research area on culture and extended the usage of Lisrel into MIS area. The result showed that organizational culture in the traditional and E-commerce Company is different in the ethical value. The research result showed that the culture is changing in the process of adopting new technology in organization, which may raise the attention of changing the management methods due to differences in culture.

## 1. Introduction

Internet and e-commerce can be claimed as the greatest changes in the 90<sup>th</sup>. "Starting from basically zero in 1995, total electronic commerce is estimated at some \$26 billion for 1997; it is predicted to reach \$330 billion in 2001-02 (near term) and \$1 trillion in 2003-05 (future)" [18]. Till now e-commerce keeps growing and penetrating in almost every perspective of social and the business area. In line with the fast growth of information technology and internet, more and more company has adopted or is exploring the feasibility of adopting the advanced information technology to enhance the enterprise knowledge management and hence the performance of the company. IT has become the major success factor of the corporations in the turbulent competitive business environment. Peter Drucker predicted in 1988 "The typical large business 20 from now, will have half the levels of management and one-third the managers of its counterpart today"; "Businesses have little choice but to become information-based" [4].

With the development of e-commerce many concerns come out either to produce the hinder the process of electronic business. Since e-commerce penetrates into many aspects of the industry many factors will be influenced by electronic commerce. On the definition of e-commerce, different party has different perspective,

"Depending on whom you ask, electronic commerce has different definitions..." [14]. According to Dow Johns definition about e-commerce, an e-commerce company is different from traditional companies mostly on how much part of its revenue comes from electronic transactions [10]. But there should be other things that are different from revenue since an e-commerce company is different from a traditional company in many ways. These differences will affect the unseen factors under a company or organization. Organization culture is one factor that gains a lot of attention in recent years [15] [3] [11][8][16]. Though many researches devoted to identify out the relationship between organization growth and organization culture, few have paid attention to the culture in the newborn e-commerce company. Some researches have discussed the role of organization culture in the process of adopting advanced technology, such as intranet [3], TQM [2], and other technologies [8]. In Ruppel's discussion, Setting up an Intranet within the organization will not only save the cost of transaction within organization but also enhance the efficiency of communication and expand the extent of communication within organization. Thus Intranet will reduce the hierarchy of the organization and influence the culture of the organization. But culture in turn will influence the adoption of Intranet. "Without a match between the culture of an organization and the cultural assumptions embedded in an IT innovation, a costly implementation failure is likely to occur" [22]. Since human's behavior in face-to-face environment is different from the virtual environment, the employee's behavior in e-commerce company environment will be different from the common company environment. For instance, evidence shows that people in non-face-to-face environment will more willingly to tell the talker truth, which mean that the communication within a virtual community will more real and effective. Thus the culture of the e-commerce organization will be different too. Due to Internet and e-commerce some aspects inner the organization must have been changed but what's been changed and what's not, and if some aspects changed how to identify such changes are also a question. Intranet changes the communication style among people and enhanced the effectiveness of communication among people too. In one aspect it must have some effect on culture. Ruppel pointed out that culture within the organization will first

affect the implementation and operation of Intranet then in turn will be affected by Intranet after successfully implementing the Intranet [9]. Such phenomenon raises the questions as what the culture difference is between e-commerce companies and traditional companies. What kind of culture is more obvious and thus helpful in e-commerce companies? How to find out the difference and what kind of difference between e-commerce organizations and traditional one? Answers to such questions are meaningful for managers in e-commerce companies. Identify out how and in what way the electronic transactions mode will affect an organization's culture structure will be very beneficial to those who want to manage their companies well and those who want to setup their business in electronic commerce area. Thus this paper try to find out the culture dimensions in the e-commerce companies and compare the culture difference between e-commerce companies and traditional companies. Gordon used CFA (Confirmatory Factor Analysis) to compare self-other disagreement between self-rating and other-rating score and give a useful and easy approach in comparing two groups or two sources. This approach can also be applied to compare any form of disagreement between two sources [6]. This paper is to identify the difference of the culture in e-commerce companies and show a new method from different aspect to do research on cross-group research. Also this method is new to MIS research. Our two sources here are e-commerce companies and traditional companies.

## 2. Literature Review

To illustrate our discussion, we first need to make clear what's our subject to be involved, that is, we first must make a clear definition on electronic company companies. They are many definitions about e-commerce since the first time it come.

"Depending on whom you ask, electronic commerce has different definition.

From a communications perspective, Electronic commerce is the delivery of information, products/services, or payment over telephone lines, computer networks, or any other electronic means.

From a business process perspective, electronic commerce is the application of technology toward the automation of business transactions and workflows.

From a service perspective, electronic is a tool that addresses the desire of firms, consumers, and management to cut service costs while improving the quality of goods and increasing the speed of service delivery.

From an online perspective, electronic commerce provides the capability of buying and selling products and information on the Internet and other online services" [14, p.3]. Turban put up with the definition

pure versus partial electronic commerce [5, p.5]. A more attractive view is from Dow Jones index, according to its definition, "It will include only companies that generate a minimum of 50 percent of their revenue from the Internet. The DJII will be made of two subindexes: "Internet Commerce" and "Internet Services." These 40 stocks represent 80 percent of the market capitalization of Internet stocks." According to this definition, only 25 companies in services section and 15 in commerce section. Though it is only restricted into the companies with initial publishing the definition could be extended to companies that didn't not have initial publishing but will have 50% or more of their annual revenue comes from Internet.

Culture concept played a key variable in the success or failure of organizational innovations and will enter its third decade of active life in the field of organizational studies [11]. On the reviewing of recent literature on organization we could find many on implementation issues of organizational culture. A lot of researchers linked the culture with the innovation in the organization. Some of them directly discussed the role of culture in the process of technology implementation or technology transfer or organizational performances. Ben and Rabi discussed the influence of the culture on the process of the technology transferring and pointed out that organizations with similar culture is easy to transfer technology inter-organizations [2]. Ruppel point out that on the process of sharing knowledge through intranet organizational culture has an important effect in the initial state of implementing intranet. [3]. James and Roger wrote a paper on the current organizational culture dimensions that occurred in recent organizational culture literature and identified out 8 dimensions [11]. Gregory and Christopher pointed out that though it doesn't have a direct effective in the implementing advanced manufacturing technology, organizational culture do act and have an effect in the long run during the process of technology implementation [8]. Ruppel [3] did some research on culture's effect on the success implementation of Intranet and pointed out that trusting and ethical culture is very important on the encouragement of sharing tacit knowledge over Intranet, which implied the success of the implementation of Intranet. Ruppel also suggested that that the people-based issues such as culture are increasingly important, and they represent a significant potential barrier to effective use despite the adoption of the technology. In his study he validates the need for the study of organizational culture as a factor in the adoption and implementation of IT innovations such as Intranets, as well as other types of innovations designed to facilitate communication. Even after implementing the Intranet successfully, mismatches in culture will still reduce the effect of the Intranet [3]. When talking about the relationship between organization design, organization culture and AMT (Advanced Manufacturing Technologies), Zammuto and

O’Connoh think the AMT failure is concerned with organization design and culture serve as a constrain. Given all these literature on organizational culture and technology aspect of organizations we can conclude that culture have relationship with the technology aspect of an organization. Turning the view to the E-commerce companies, which relies highly on Internet to conduct business, it isn’t hard to relate organizational culture with electronic companies. My concern is a) will the organizational culture in E-commerce companies be different from the traditional companies? b) if different, in what aspect or what dimension will it be different? Except above literature, in psychology and management field, there are many research on cross-culture research and cross-group research at organizational level. They provide very good methodological framework in conducting research or culture or cross-culture research [21] [6] [7]. This paper will use the cross-group research methods to compare and identify the culture difference between E-commerce companies and traditional companies.

In the definition of culture there are voices from many researchers [9][13]. “Careless utilization of the concept, for instance, refers the sharing of language, nationality, race, religion, and so on...” [9, p.110]. “Culture exists at three levels of abstraction: assumptions, values, and artifacts. The essence of culture is the set of basic assumptions that people share regarding such things as human nature, social relationships, and relationships among social institutions and their environment.” [13]. Researchers conducted analysis about culture at three levels, and values are more accessible than assumptions and more reliable than artifacts [13]. Wiener pointed out that shared values system is one of core measurable components of organizational culture [23]. Culture can be conceptualized and quantified as shared values in organization environment. Values in culture represent symbols, norms, and other culture activities around them [12]. When conducting empirical researches on organizational culture, lots of researchers analyze it at values level [15][3][11][8][17][20]. The most useful model for organizational culture at values level is the Competing Values Model (CVM) developed by Quinn, R.E and Rohrbaugh in 1983 [19]. Though there are other dimensions or frameworks for organizational culture analysis, for instance, in Chatman and Karen’s paper, 7 dimensions of organizational culture, innovation, stability, people orientation, outcome orientation, easygoingness, detail orientation, team orientation [12], based on extant literature on organizational culture, Schroeder and Mauriel synthesized 8 dimensions for organizational culture, the basis of truth and rationality in the organization, the nature of time and time horizon, motivation, stability versus change/innovation/personal

growth, orientation to task & coworkers, isolation versus collaboration/cooperation, control, coordination, and responsibility, and orientation and focus – internal and /or external [11], these dimensions are reflected that dimension in competing value model and is not so structured as CVM, which experienced content and construct validity [3]. So we will use CVM model as the basis of our analysis. Next section we will briefly introduce the competing values model.

## 2.1 Competing Values Model

Quinn’s competing values model is initially developed for the organizational effectiveness [19]. While conducting research on effective organizations Quinn found out that there are two dimensions similarly exist underlying effective organizations. The first dimension is flexibility-control and the second is internal-external. Flexibility –control axis focus on the changes in the organization and varies along the axis from flexible to controlled or structured mechanism. Internal-External dimension is related to organizational focus and is concerned with activities existing internally or externally. Internal focus emphasizes the changes in the existing organization and the external focus emphasizes the reaction to the competition, adaptation and interaction with the external environment. A quadrant organizational type is generated through crossing these two dimensions at the center (Figure 1). Each quadrant has its own means and ends. “Quinn and Kimberly subsequently argued that the competing values model could be used to ‘explore the deep structures of organizational culture, the basic assumptions that are made about such things as the means to compliance, motives, leadership, decision making, effectiveness values and organizational forms” [20, p.711].

The above quadrant will exist in organizations. An organization couldn’t have only one dimension. When the organization maintains a balance among four quadrants it will maximize its effectiveness. Though this four dimension measures the culture well but it may miss something that Internet-based culture have. For instance trust between employees “openness and honesty, sincere service attitude toward membership,” and a “high trust culture for shared learning” dimension of ethical work climate, with respect to Intranets and the organizational culture [3]. Ruppel developed a new measurement framework that includes ethics and trust measurement within organization. Hence we have a five-dimension culture construct. Figure 2 shows the dimensions of organizational culture from Ruppel’s model. In Ruppel’s model an additional dimension Ethical is added to values the culture with openness and trust.

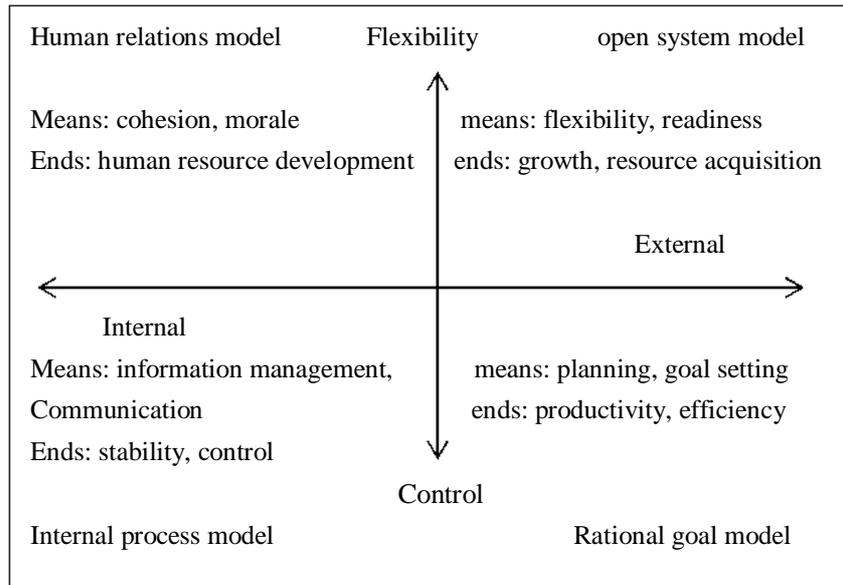


Figure 1. Competing Values Model: Organizational Effectiveness

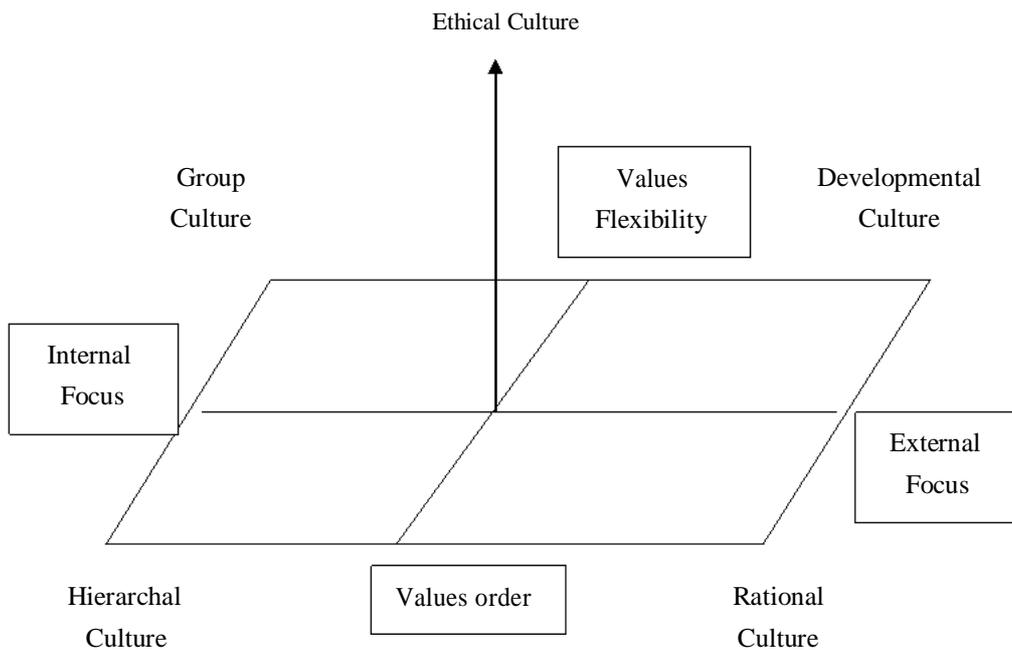


Figure 2. Ruppel's culture dimension extended from Competing Values Model

In above figure e-commerce companies have five dimensions to measure organizational culture. A development culture is a culture values flexibility and external focus [3]. An organization showing strong developmental culture will be adapted and change to external environment flexibly when face turbulent and complex external environment. A group culture values flexibility and have an internal focus. An organizational showing strong group culture will focus on the human resource development, cohesive alliance between

organizational members, organizational development. A hierarchical culture is control-based and has an internal focus. An organization showing strong hierarchical culture will values structural systems, policies and rules in organization and it will not adapted rapidly to the change in the outside environment. A rational culture is control oriented and has an internal focus. An organization showing strong rational culture values order and rightness of organization action. The managers in rational culture organization will always adopt actions

that will lead the organization to maximize the profits or productivity of organization. Though group culture reflects some kind trust between organizational members it could not replace the position of ethical culture. “While the competing values framework describes values often used for decision making, it does not include specific measures for trust and an ethical work environment” [3]. Thus our organizational culture will have five dimensions to measure E-commerce companies. Figure 3 is the measurement model of the new organizational culture.

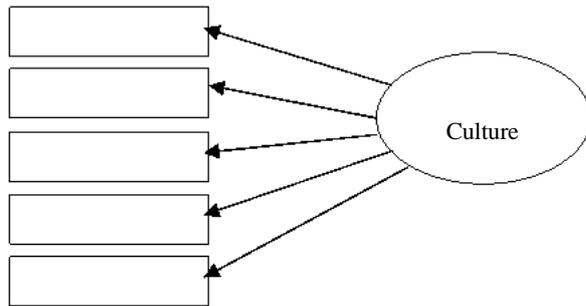


Figure 3 the culture dimensions

### 3. Hypothesis

Through the literature review we know that for an organization to maximize its effective the organization will have a balance in all the five dimensions. An organization couldn't have only one culture type. And different organization will show different degree of culture types to maximize its performance [17]. In Ruppel's empirical studies during developmental culture and ethical culture have an positive effect during the process of intranet implementation. Group culture, rational culture and hierarchical culture have no direct effect to facilitate the process of intranet implementation. According to Ruppel's explanation the group culture's effective will appear in the long run. This point is the same as the result of Stock [8], who conducted an empirical study on the role of organizational culture for external focus culture will be strong in E-commerce companies. Thus we will give our hypothesis 1 & 2.

H1: Developmental culture in E-commerce is different from those in the traditional companies. internet, an environment that is changeable, flexible and technology oriented. Also through internet it must have

H2: Group culture in E-commerce is different from those in the traditional companies. the AMT (Advanced Manufacturing Technology). E-commerce companies conduct business through rich communications with

outside world. That means an

At the same time, Internet will values trust when conducting business since people interact with each other through a virtual channel instead of face to face. Thus we give our hypothesis 3.

H3: Ethical culture in E-commerce companies is different from those in traditional companies.

For rational culture and hierarchical culture studies related with technology implementations showed that it is not very strong in organizations values innovation and technology and creation. Thus we give our Hypothesis 4 and 5.

H4: rational culture in E-commerce companies is the same as those in traditional companies.

and technology and creation. Thus we give our Hypothesis 4 and 5.

H5: Hierarchical culture in E-commerce companies is the same as those in traditional companies.

### 4. Research Methodology

In this study we first use sample survey to conduct the data collection, then use CFA-based (Confirmatory Factor Analysis) analytical procedure to compare the culture difference between E-commerce and traditional companies.

#### 4.1 Measurement & Questionnaire

The measurement framework of the five constructs extended from Ruppel [11] is as following. According to Ruppel's illustration. The measurement model is through content and validity test.

##### 4.1.1 Development Culture (item 1, 2, 3, 4)

1. The glue that holds my group together is commitment to innovation and development.
2. There's an emphasis on being first with products and services.
3. My group emphasizes on growth through developing new ideas.
4. Developing new products or services is important.

##### 4.1.2 Rational Culture (item 5-10)

5. The relationship with our customers and suppliers can best described as cooperation and trust.
6. I have found that my employees are usually dependable, especially when it comes to things important to me.
7. My department is a very product oriented place.
8. People are concerned with getting job done.
9. The glue that holds my group together is emphasis on task and goal accomplishments.
10. A production and achievement orientation is shared.

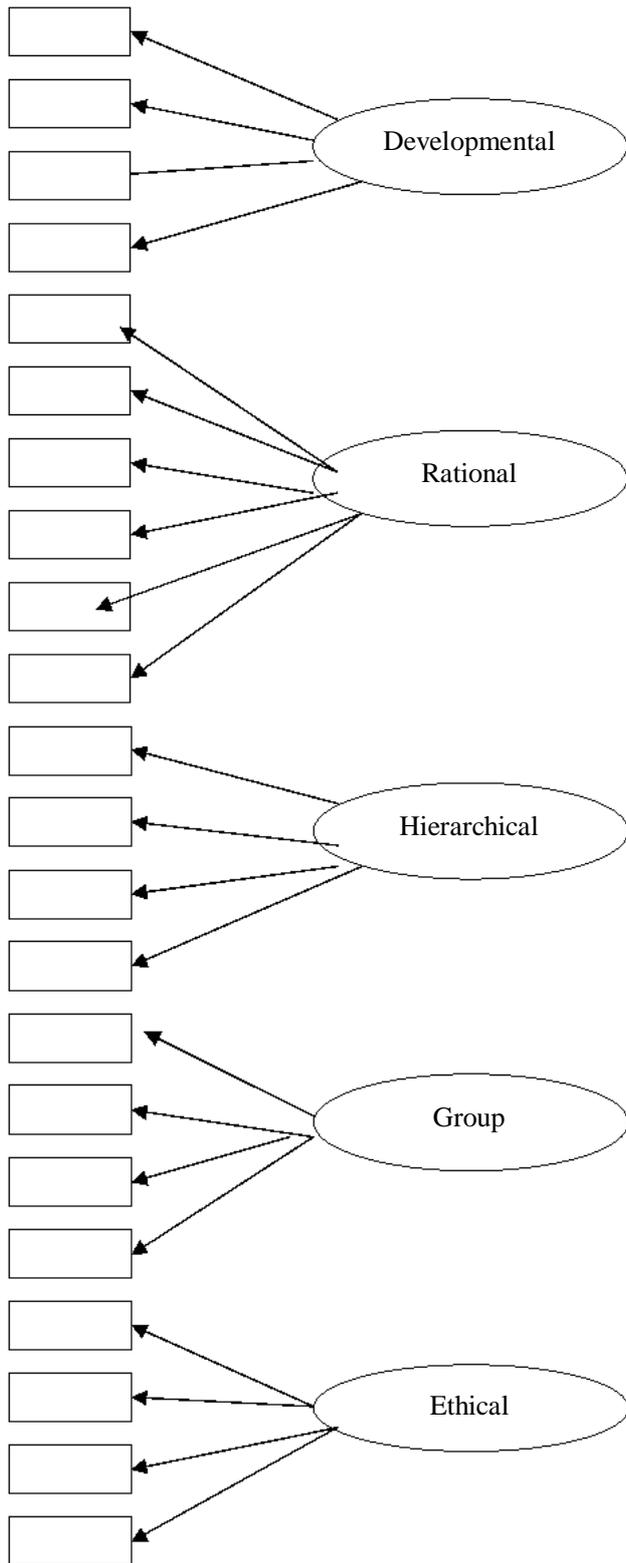


Figure 4. The CFA model

4.1.3 Hierarchical Culture (item 11-14)

11. My department is a very formal and structured place.
12. People pay attention to procedures to get things done.
13. The glue that holds my group together is formal rules and policies.

14. Following rules is important.

4.1.4 Group Culture (item 15-18)

15. My department is a very personal place like an extended family.
16. People seem to share a lot among themselves.
17. My group focuses on human resource.
18. Morale is very important.

4.1.5 Ethical Culture (item 19-22)

19. In this organization people are mostly out for themselves.
20. Our major concern in this organization is always what is the best for other person.
21. The atmosphere within this organization is best described as one of mutual confidence and trust.
22. The environment is largely ignored. With upper management interest focused on inward attempting to maintain the stability and equilibrium of the organization. In order to attain these goals managers focus on measurement, documentation and information management.

4.2 Research Method and sample frame

We use sample survey to collect data of the two groups in this paper. Confirmatory factor analysis (CFA) will be used in this paper. We identify two groups as E-commerce companies and traditional companies. For each group we focus on the culture aspect of the organization on research. Ruppel's new frame of culture with 5 dimensions will be used in this paper as the research object. For each dimension of culture we have several items to measure. In this paper we can compare the measurement model of the culture to find out the difference between organization with Intranet and without Intranet. Gordon pointed out that there are two kind of disagreement between two groups, conceptual disagreement and psychometric disagreement [6]. We will analysis this two kind of disagreement to identify the culture difference between two groups.

4.2.1 Sample frame

For the ideal situation, we can first get the directory of the enterprise in Hong Kong from Hong Kong industry Bureau and give them a phone call first to ask them whether they have Intranet How did you define "an organization with an Intranet"? . Then we identify those who have Intranet from all. The next step is to select the 500 companies each with random sample method from those who have Intranet and those who haven't. Then we send questionnaire to these 1000 companies and explain our research purpose and guarantee that we will give them the result of the result to get a high rate of feedback. The questionnaire will be sent to 2 senior managers and one IT manager or CIO How different are the views of the senior managers and the IT manager? For these two groups we get the raw data and can use these data to make a CFA analysis.

### 4.3 Analysis

After collecting data we use Lisrel to conduct a CFA analysis to compare the culture difference between E-commerce and traditional companies. In above discussion we ave our model with 5 dimensions and 22 items.

#### 4.3.1 Conceptual Disagreement

Conceptual disagreement exists when people in E-commerce and traditional companies use different conceptual form or different reference to conceptualize culture. For example people in E-commerce may conceptualize culture with 5 dimensions but people in the traditional companies may conceptualize it only with 4 dimensions. Or people in E-commerce use four items to conceptualize developmental culture while people in traditional companies culture may use 3 or 2 items. Even people in Intranet-based-organization and non-Intranet-based use the same item to measure the same dimension they may give the same item of the same dimension different loading. All of the above difference belongs to the conceptual difference.

##### 4.3.1.1 Difference in Factor form

The culture will display factor form equivalence if people use the same dimension to measure culture in E-commerce and traditional companies on condition that each dimension in both groups has the same item. In the absence of factor form equivalence the difference of culture between E-commerce and traditional companies due to the way people concept the culture. This difference can be referred to facilitate the management and enhancement of the performance of Intranet.

##### 4.3.1.2 Difference in Factor loading

Factor form equivalence exists means that people use the same dimensions and the same numbers of items to measure culture or people in the two groups conceptualize the culture with the same pattern. But factor form equivalence is only a necessary but not sufficient condition for comparing the equivalence of culture across the model. Even people conceptualize culture with the same pattern they may give the same item different weight. For example people in E-commerce may put more emphasis on the group culture and give items of group culture more weight and its countpart may not. Difference in factor form is known as factor form invariance.

#### 4.3.2 Psychometric Disagreement

Psychometric disagreement exists when people in the two groups agree conceptually on the culture but may respond to the scale in different ways. Differences may be manifested as source-specific biases. For example even though people in Intranet-based and traditional companies may conceptually agree on the culture but they be different in variability within group or random measurement errors. Five sources of psychometric disagreement will be examined here. They are (a) difference in random error, (b) difference in the

variability of latent factors (culture dimension), (c) difference in correlations among latent factors, (d) differences in latent means, and (e) difference in starting value of latent factors. For future information about these 5 disagreements please further reference [6].

##### 4.3.2.1 Difference in Random Errors

Difference in random errors is related with the reliability issue. An observed item score consists of a hypothetical true score plus random measurement error. They are two sources of errors, system error and random error. Random error may be attributable to the following people's characteristics: unfamiliarity with scale items, inexperienced with the question format, informational constraints, errors in marking responses, carelessness, and so on [6]. In culture context measurement random error may be due to people in Intranet-based and non-Intranet-based culture understand the question in different extent.

##### 4.3.2.2 Difference in Latent Factor Variability

Difference in latent factor variability exists when people in Intranet-based and traditional companies have a large within group difference. For example people in E-commerce have a large variability for group culture dimension means that some people in E-commerce give a very high score for group culture and some people may give it a very low score. If the variability difference is large it means that people in the two groups have a very high difference between in conceptualize the culture.

##### 4.3.2.3 Difference in Correlations Among Latent Factors

Correlations among latent factors measure the interaction effect between dimensions. Halo effect, which is the tendency to generalize the score of culture across dimension, can be operationalized as correlations among latent factors. Because halo inflates correlations among different dimensions the high correlation is affected by greater halo effect. When differences in correlations among latent factors exist, people in Intranet-based and traditional companies have different halo effect.

##### 4.3.2.4 Difference in Starting Value of latent factor

Though people may conceptualize the culture in the same way with equal factor loadings they may also have different perspective on the starting value of the construct. For example people in both groups may think group culture is low but one group may give low value as 3 and another group may just give it as 1. So the difference in starting value of the latent factor is required to compare latent means. If people couldn't have the same starting value of latent factor they couldn't compare at the same level and the comparison will be no sense.

##### 4.3.2.5 Difference in Latent Means

To compare latent means we have the conditions that people in the two groups conceptualize the culture in the same pattern and with equal factor loadings on the constructs. At the same time equivalence in starting value of the latent factors is required. If all these conditions are fulfilled we can compare the latent mean score of culture to see if people in Intranet-based and traditional

companies are different in culture. If the difference does exist we have conclusion that culture in E-commerce and traditional companies are different.

## 5. Analysis Result

A total of 117-finished questionnaires were collected, 71 of which have intranet and 46 of which don't have. Following seven disagreement tests and after running Lisrel we get the following test results. One thing need to be noticed is that due to small sample size we only do two steps test till the factor-loading difference. From the average score of the performance questions asked we find out that organization with intranet have better performance than those who doesn't have. In the following section we first introduced the result from Lisrel then discussed the results.

### 5.1 Factor form Invariance Test

From the result from table 1 we can see that Chi-Square of stacked model equals to the summation of the Chi-Square of both groups. So we can't reject the fact form invariance. The  $\chi^2$  of the stacked model are called as  $\chi^2_{uncon}$  and will be used in the subsequent test.

### 5.2 Factorial Invariance Test

To see if there's any other difference between two groups we need to do the factorial invariance test to check if the factor loadings are the same for both groups. The purpose of this test is to check whether people in the two groups give each item of the constructs the same importance given that they conceptualize the construct in

the same way. If there is a factorial loading difference between groups it means that the measurement models between two groups are different. For this particular test if the factorial invariance exist it is due to the people in intranet-base organization and non-intranet-based organization give the item of 5 culture dimensions different importance. If we want to do further comparison we need to find out which dimension, developmental, group, Rational, Hierarchical or Ethical, contributes to the significance of the difference. Even fourthly we can find out on which item people give different importance. This is done by test the factor ratio invariance test item by item. This test can tell us the detail information of the difference between the two groups. If the factorial invariance exists between two groups we need to do further test to see if there's any other difference such as, theta-delta test, intercept difference between groups. To check the factor loadings on the five constructs we first constrain all the parameters and see if there is any difference between the groups then make a comparison between the unconstrained baseline model to see if it is significant. Since the five constructs are independent in this model we need to constrain single construct one by one to check if the factor loadings of the five constructs are the same. Table 2 shows the results of the factorial test. For example for construct one we constrain factors of construct 1 of intranet-based organization the same as non-intranet-based organization, that is  $\lambda_{2,1}^{(1)} = \lambda_{2,1}^{(2)} \lambda_{3,1}^{(1)} = \lambda_{3,1}^{(2)} \lambda_{4,1}^{(1)} = \lambda_{4,1}^{(2)}$  and free all other parameters. The same is true for the other four constructs.

Table 1 Result of Fact form Invariance Test

	Chi-Square	df	RMSEA	CFI	NNFI	IFI
Intranet	1.85	199	0.00	0.93	0.70	0.83
Without Intranet	1.31	199	0.0	0.97	0.53	0.61
Stacked Model	3.16	398	0.0	0.95	0.91	0.94

Table 2 Results of factorial invariance test

Test	Model	$\chi^2$	df	$\Delta\chi^2$	$\Delta df$	TLI	CFI	RMSEA
1	Unconstrained baseline model	3.16	398			.91	.95	0.0
2	Fully constrained model	15.83	415	12.67	17	.91	.77	0.0
3.1	Loadings on construct1 ( $\xi_1$ ) constrained	4.22	401	1.06	3	.91	.94	0.0
3.2	Loadings on construct2 ( $\xi_2$ ) constrained	5.23	403	2.07	5	.92	.92	0.0
3.3	Loadings on construct3 ( $\xi_3$ ) constrained	4.05	401	0.89	3	.94	.94	0.0
3.4	Loadings on construct4 ( $\xi_4$ ) constrained	3.78	401	0.62	3	.96	.94	0.0
3.5	Loadings on construct5 ( $\xi_5$ ) constrained	11.72	401	8.56**	3	.91	.83	0.0

\*\*Note: P<0.05

Through the factorial invariance test construct by construct we can see that construct 5 is significant. This means that people in intranet-based organization and those in non-intranet-based organization use the same item to measure culture dimension but they give ethical culture different importance. In general perspective, people in two groups use same way to think culture. But they have different value on ethical culture. For the other four culture dimensions, they have the same values. This result reveals the culture dimension we discussed earlier in this paper. Ethical culture is special issues in new network environment which change the way people communicate.

So the model stops in this step because we find the difference between two groups. Since the further disagreement test is based on a factorial invariance test model we didn't do further test here. But through fixing the model we can either use a partial factorial invariance model or just remove the significant construct or just interpret the non-invariant items as data. How different are the two groups on the ethical culture dimension?

## 6. Contribution, Conclusion and Future Study

This paper explores the culture issue in the new technology age. Adopting Ruppel's new culture framework developed from traditional perspective on culture the paper tested the culture difference between organization with intranet and without intranet. Using Confirmatory Factor Analysis method with Lisrel the paper explored the research area on culture and extended the usage of Lisrel into MIS area.

The research result showed that the culture is changing in the process of adopting new technology in organization, which may raise the attention of changing the management methods due to differences in culture. But the paper only make the very first step in analyzing the differences between two groups. More detail study such as psychometric disagreement analysis should be studied in the future. In addition, detail research can be done to investigate to what extent intranet can affect company's performance. The study on other technologies', such as the effect of Internet on customers, effect on culture also can be done in the future.

## Reference

[1] Athena Xenikou & Adrian Furnham. "A correlational and Factor analytic study of four questionnaire measures of organizational culture," *Human Relations*, 1996,49(3), 347-371.  
 [2] Ben L. Kedia & Rabi S. Bhagat. "Culture constraints on Transfer of technology across nations: Implementations for research in international and comparative management," *Academy of Management Review*, 1998,13(4), 559-571.  
 [3] Cynthla P. Ruppel & Susan J. Harrington. "Sharing Knowledge Through Intranets: A Study of Organizational Culture and Intranet Implementation," *IEEE Transactions on*

*professional communication*, 2001,44(1), 37-52.  
 [4] Drucker Peter F.. *The coming of the new organization*, Harvard Business Review on Knowledge Management, Harvard Business School Press, 1988 Jan-Feb.  
 [5] Efraim Turban, Jae Lee, David King & H. Michael Chung. *Electronic commerce: a managerial perspective*, Prentice Hall 2000.  
 [6] Gordon W. Cheung. "Multifaceted conceptions of Self-other ratings disagreement," *Personnel Psychology*, 1999,52(1), 1-36.  
 [7] Gordon W. Cheung & Roger B. Rensvold. "Testing factorial Invariance across Groups: A reconceptualization and Proposed New Method," *Journal of Management*, 1999,25(1), 1-27.  
 [8] Gregory N. Stock & Christopher M. Mcdermott. "Implementing advanced manufacturing technology: the role of organization culture," *Production and Inventory Management Journal*, 2000,41(3), 66-71.  
 [9] Harry C. Triandis, Marvin D. Dunnette, & Leaetta M. Hough. *Handbook of Industrial and organizational psychology 2<sup>nd</sup> edition*, Volume 4, Consulting psychologists press, Inc.  
 [10] <http://news.cnet.com/news/0,10000,0-1005-200-338866,00.htm>  
 [11] James R. Detert, Roger G. Schroeder & John J. Mauriel. "A framework for linking and improvement initiatives in organizations," *Academy of Management Review*, 2000,2(4), 850-863.  
 [12] Jennifer A. Chatman & Karen A. Jehn. "Assessing the relationship between industry characteristics and organizational culture: How different can you be?" *Academy of Management Journal*, 1994,37(3), 522-553.  
 [13] John Hendry. "Cultural Theory and Contemporary Management Organization," *Human Relations*, 1999,52(5), 557-577.  
 [14] Kalakota, Ravi. *Electronic commerce: a manager's guide*, Addison Wesley Longman Inc, 1997  
 [15] Khalifa N Al-khalifa. "using the competing values framework to identify the ideal culture profile for TQM: A UK perspective," *International Journal of Manufacturing Technology and Management*, Geneva, 2000,2(1-7), 1024-1040.  
 [16] Larry Mallak. "Understanding and Changing your organization's culture," *Industrial Management*, 2001,43(2), 18-24.  
 [17] Larry W. Howard. "Validating the competing values model as a representation of organizational cultures, *The international journal of organizational analysis*," 1998,6(3), 231-250.  
 [18] OECD Report. *GROWTH OF ELECTRONIC COMMERCE: PRESENT AND POTENTIAL*, [http://www1.oecd.org/subject/e\\_commerce/ebooks/027-054.pdf](http://www1.oecd.org/subject/e_commerce/ebooks/027-054.pdf)  
 [19] Quinn, R.E. & Rohrbaugh, J.. "A spatial model of effectiveness criteria: Towards a competing values approach to organizational analysis," *Management Science*, 1983,29(3), 363-377.  
 [20] Raymond F. Zammuto & Edward J. O'Connoh. "Gaining Advanced Manufacturing Technologies' benefits: the roles of organization design and culture," *Academy of Management Review*, 1992,17(4), 701-728.  
 [21] S. Tamer Cavusgil & "Ajay Das. *Methodological Issues in*

Empirical Cross-cultural Research: A survey of the Management Literature and a Framework,” *Management International Review*, 1997,37(1), 71-96.

[22] T. Romm, N. Pliskin. Y. Weber, & A. Lee. “Identifying organizational culture clash in MIS implementation: When is it worth the effort?,” *Information & Management*, 1991,21(2), 99-109.

[23] Yoash Wiener. “Forms of Value Systems: A focus on organizational Effectiveness and Culture Change and Maintenance”, *Academy of Management Review*, 1998,13(4), 534-545.

# A Theory of Common Dealing with the Internet as an Innovative Distribution Channel

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## Abstract

After the emergence of the Internet, an interesting question arises that what is its impact on the firms' channel and pricing strategies. This paper applies game theory to study the strategic interactions between rational manufacturers, retailers, and consumers, and it generates the following results: 1. The presence of the Internet allows imperfectly competitive manufacturers to better coordinate their pricing, targeting, and channel strategies, thereby minimizing the agency costs involved in common dealing at the traditional outlets, which in turn enhances the manufacturers' profits. 2. Exclusive dealing may and may not become more prevalent in the presence of the Internet. It all depends on the ratio of the population of switchers to the entire population of consumers. 3. The presence of the Internet allows a monopolistic manufacturer to screen consumers by serving different people at different outlets. Screening is less effective, however, in the case of imperfect competition. 4. A dynamic adjustment process is obtained which describes how a manufacturer should optimally change his channel and pricing strategies when the population of the Internet purchasers grows over time.

## 1. Introduction

The prevalence of the Internet brings a great deal of business opportunities and potential markets. For one thing, manufacturers do not have to rely on retailers to sell their products to final consumers. Through the Internet, they can directly contact worldwide consumers and have better understanding about what consumers want and need. Similarly, retailers can also serve consumers that they could not have reached otherwise. However, by making searching easier for consumers, the Internet is said to intensify price competition. For example, Bakos [1] suggests that lower search cost on the Internet would lead to more severe price competition and lower profits. Brynjolfsson and Smith [2] show empirically that the price competition on the Internet is sharper than that in traditional channels for standard products like CD and books. However, some scholars have opposite views and think that a low search cost will not necessarily intensify price competition. For example, Lal and Sarvary [3] point out that for non-digital products under some conditions, consumers who search in the absence of the Internet may

shop their familiar brands on the Internet without searching. Therefore, it is possible that the presence of the Internet not only enhances the consumer loyalty but also eases the price competition between firms.

Before the emergence of the Internet, manufacturers could only sell their products to consumers in the traditional channels. If the channel is not vertically integrated, manufacturers have to contact consumers through retailers. In general, a manufacturer hopes that retailers can provide various in-store promotions for its product to increase its sales volume, including in-store advertisement, displaying its product, or even persuading consumers to switch to the manufacturer's brand on the point of purchase. However, the retailer who maximizes the profits from its assortments would promote the brand with the highest profit margin. In fact, the retailer may even use the leading brand with a lower margin to build traffic while persuade consumers to buy another high-margin brand on the point of purchase. To solve the incentive problems, the manufacturer could choose exclusive dealing [5]. Exclusive dealing is a contractual arrangement between a manufacturer and its dealers where the latter agree not to carry brands competing with the manufacturer's brand. In contrast, under common agency, manufacturers allow their dealers to carry brands competing with their own. One stream of previous literature centers on how the channel structures, in particular, exclusive dealing or common retailer, chosen by competing manufacturers affect the intensity of competition among manufacturers. Mathewson and Winter [6] argue that the retailer would not accept exclusive dealing offered by a manufacturer unless the associated wholesale price is low enough, which implies intensive potential competition between manufacturers in order to be selected as the only brand carried by the retailer. Others argue that under exclusive dealing, the perceived demands of manufacturers are more inelastic than under common dealership, thus softening the upstream competition [4] [8]. It happens because under exclusive dealing a manufacturer knows that the decrease in its wholesale price will result in not only the decrease in its own retail price but also the retail price of a competitive product set by the other exclusive dealer. In addition to the associated intensity of competition, cost is another concern when manufacturers consider whether to impose exclusive dealing or not. When manufacturers sell

products through a retailer, they would incur a setup cost. Under common agency, manufacturers could share the setup cost, thus having a positive externality compared with exclusive dealing.

The emergence of the Internet channel may give manufacturers a way to overcome a retailer's incentive problems. The Internet channel differs from traditional channels in two important ways. First, on the Internet it is consumers that decide what information to search and to retrieve. Therefore, online retailers can not influence/change consumers' brand preferences as much as traditional retailers. Second, the Internet channel can not reach consumers who do not have access to the Internet. Manufacturers when designing their optimal channel strategies must take into account the distinctive properties of the traditional channel and the Internet channel into account.

The purpose of this paper is twofold. First, we analyze how the presence of the Internet may help manufacturers alleviate a traditional retailer's incentive problems. Second, we characterize imperfectly competitive manufacturers' equilibrium channel strategies in the presence of the Internet.

To achieve the above two objectives, we consider a model with two manufacturers and two traditional retailers. For each manufacturer's brand, there are two kinds of customers, loyals and switchers. The segment of loyals have higher reservation price for the manufacturer's brand and will not be influenced by traditional retailers on the point of sales. In contrast, the segment of switchers have lower reservation price and can be persuaded by traditional retailers to buy the competing brand. Before the emergence of the Internet, a manufacturer marketing strategy crucially depends on two factors. The concern for double marginalization, which determines the segments that manufacturers want to serve and the retailer's persuasion power affects the choice of exclusive dealing or common agency. After the emergence of the Internet, the consumer market is redefined according to whether consumers have access to the Internet. Thus the proportion of consumers using Internet and the difference in cost between traditional channel and Internet channel would also affect the manufacturers' channel design and the targeting decisions in different channels. This paper applies game theory to study the strategic interactions between rational manufacturers, retailers, and consumers, and it generates the following results:

1. The presence of the Internet allows imperfectly competitive manufacturers to better coordinate their pricing, targeting, and channel strategies, thereby minimizing the agency costs involved in common dealing at the traditional outlets, which in turn enhances the manufacturers' profits.

2. Exclusive dealing may and may not become more prevalent in the presence of the Internet. It all depends on

the ratio of the population of switchers to the entire population of consumers.

3. The presence of the Internet allows a monopolistic manufacturer to screen consumers by serving different people at different outlets. Screening is less effective, however, in the case of imperfect competition, a dynamic adjustment process is obtained which describes how a manufacturer should optimally change his channel and pricing strategies when the population of the Internet purchasers grows over time.

## 2. Literature Review

One of The issues that attract many researchers' attention after the prevalence of the Internet is how the Internet affects the intensity of competition among firms. Although some scholars (eg, Lal and Sarvary, 1999) argue that the non-digital attributes of products may influence consumer behavior, which are decided by the concern of extra transaction cost, and cause the favor of existing brand. According to this argue, the firm will face better pricing condition. Nevertheless, most people agree that the development of the Internet has reduced searching cost and made consumers get information easily, which will lead price competition and sharply reduce price level. Brynjolfsson and Smith (2000) have empirically studied the price competition in two categories - CD and books - to exam whether the price competition on Internet would be more severe than the traditional channel. CD and books are both highly homogeneous products, which means that the product quality will not vary within different channels. The result shows that the product prices on web are lower than on brick, which means that pricing wars are more intensely on virtual world. Besides, the shift scale of price on web store is 1% of it on physical store, which means that the Internet trades possess lower menu cost and are more sensitive on price. Interestingly, the price dispersion among web retailer is larger than which among conventional retailer, and the leading firms in CD and books market are not the one who marked the lowest price. Firms adopt low price strategy shared few market value, which means purchasing cost is not the only concern of buying decisions even there are homogenous products. The degree of trust in website, brand, and service are important to buying decisions. Consequently, the homogenous products may not necessarily lead to competition on price on virtual channel.

Exclusive dealing is a commitment between manufacturer and retailer thatretailers agree not to carry the competing brands. That means a manufacturer requires its retailers only to sellits products. The issues of exclusive dealing in the past researches can be categorized into three types: one is the impact of exclusive dealing to social welfare; two is the equilibrium channel structure, including exclusive dealing, common dealing, and vertical integration; three is how other marketing variables, like price and promotion, change under different channel structure.

O'Brien and Shaffer (1993) correct Lin's (1990) error and argue that manufacturers eventually choose exclusive dealing as its channel structure among exclusive dealing, common dealing and vertical integration. In their setting, the competition at retail level is monopoly and duopoly under common agency and exclusive dealing respectively. For this reason, common agency gives the retailer the power to threaten manufacturers to sell only one product. Therefore, manufacturers could not extract all profits under common agency but could under exclusive dealing. In addition, manufacturers can alleviate competition through retailers, thus it is optimal for manufacturers to choose exclusive dealing. It is worthy to notice that the retailer's pricing strategy with common agency is like product line pricing, so the consumer surplus will be extracted at most. Compared to exclusive dealing, consumer surplus under common agency is even lower.

Many studies do not consider vertical integration, and they only focus on the manufacturers' choice between exclusive dealing and common agency. Bernheim and Whinston (1985) model the retail competition as perfect competition and the retail prices are set by manufacturers. It results the manufacturer would delegate some marketing decisions to common agency in order to collude with each other. That is because common agency provides an indirect mechanism through which competing manufacturers may "sell out" to a single retailer, thereby creating incentives which generate a collusive outcome. It is worth to note that the results critically depend on that the manufacturer has the power to set retail price.

Besides Bernheim and Whinston, Besanko and Perry (1993) also model perfect competition at retail level. They continue Marvel's (1982) study on free-rider problem. Marvel indicates that a manufacturer can solve the free-rider problem through exclusive dealing. For a leading brand manufacturer, it must invest much money on advertisements to let consumers aware its brand and purchase in advance. When consumers come to the retailer's outlet, they may be attracted by other competing brands because of the low prices, thus a strange phenomenon that the manufacturer invests but increases the competitor's sales arises. After the leading manufacturer chooses exclusive dealing, the incentive problem disappears and the benefits of advertisements are surely owned by the manufacturer itself.

Besanko and Perry transform the free-rider problem into interbrand externality. Interbrand externality is that when manufacturers are common agency, the benefits of their investments are shared with each other, and hence the effect is two-sided not one-sided like Marvel's. Their study explores that manufacturers would use exclusive dealing if the costs of investment were not too high. Because a manufacturer possesses whole benefits of the investment, it induces to spend more money on advertisements and the competition is thus more intensive.

The results in O'Brien and Shaffer or Bernheim and Whinston implicate that the channel structure in the market is unique, but Besanko and Perry allow different equilibrium under different conditions, and it is closer to the real world. They also prove that exclusive dealing could maximize the social welfare under and thereby it is not right to forbid exclusive dealing from the view of social welfare.

Mathewson and Winter (1987) considers a asymmetric market, where manufacturers have different marginal production cost and the retailer is a monopoly. Because the retailer is monopoly, manufacturers have to compete on wholesale price if they want to impose exclusive dealing. They argue that when the cost has big difference, the dominant manufacturer, with lower marginal cost, could guarantee itself the market by imposing exclusive dealing without its wholesale price declining too much. Thus, the equilibrium is exclusive dealing. Obviously, Mathewson and Winter also allow different channel equilibrium in different marketing environment.

Lal and Villas-Boas (1996) consider a more general model, where manufacturers and retailers are all duopoly. In their model, the situation that one retailer distributes one product and the other retailer distributes both products may arise, so the intrabrand competition is under consideration. They argue that if the retailer-loyal segment is not too large, manufacturers both choose common agency. That is because if the retailer-loyal segment is too large, it provide higher incentive to decrease wholesale price.

There are three contributions in our study. First, we introduce multiple marketing channel in discussing exclusive dealing and common agency. Because retailers have different marketing power and consumers have different ability to access the Internet in different channel, it gives manufacturers a chance to screen by channels. The idea is that manufacturers should induce different segments to shop in different channels. When the consumer structure in a channel is more homogenous, the competition between manufacturers decreases and it leads them to be more profitable. Second, given the level of externality, the equilibrium is not thus unique. In Besanko and Perry's (1993) study, they use the share of investment to express externality, and once the level of externality is given, we could know the equilibrium channel structure. In our study, we use the setup cost to express the externality, and even the level of externality is high, manufacturers may not choose common agency eventually. That is because we consider the retailer's ability of persuasion. Because a retailer could persuade consumers to purchase some brands, manufacturers would lower wholesale price to induce the retailer to persuade for him, and it leads to intensive competition under common agency. By using the characteristic that retailers have different persuasion power in different channel, we can

show that the level of externality is not enough to decide the equilibrium. Third, the discussions about the preferences of exclusive dealing or common dealing are short of consideration of the cost difference. It implies that the cost of two kinds of dealing is the same (Lin, 1990; O'Brien & Shaffer, 1993). Marvel (1982) and Besanko & Perry (1993) take the advertisement cost into account. Although the exclusive dealing will raise the manufacturers' investment on advertisement and common dealing will ease off such competition for the reason of external effect, they also assume that the advertising costs are indifferent between exclusive dealing and common dealing. Our study argues that the establishments of each retail outlet will have a fixed cost. It can be shared if manufactures choose common dealing but not for the exclusive dealings case. It means that manufactures should consider the different costs between exclusive dealing and common dealing.

### 3. Model

In the market, there are two manufactures, manufacturer 1 and manufacturer 2, producing brand 1 and brand 2, respectively. In this article, we sometimes use  $N_1$  and  $N_2$  to represent manufacturer 1 and manufacturer 2. Assume the production cost is 0 for both manufacturers without loss of generality. The population of consumers is normalized to 1, including 4 segments: (1) Segment  $G_1$ : it consists of consumers who are loyal to brand 1 and have their reservation prices for brand 1 and brand 2 equal to  $H$  and 0, respectively. The proportion of this segment is  $(1-q)/2$ . (2) Segment  $B_1$ : it consists of consumers who are the switchers of brand 1 and have their reservation prices for brand 1 and brand 2 equal to  $M$  and  $L$ , respectively. The proportion of this segment is  $q/2$ . (3) Segment  $G_2$ : it consists of consumers who are loyal to brand 2 and have their reservation prices for brand 1 and brand 2 equal to 0 and  $H$ , respectively. The proportion of this segment is  $(1-q)/2$ . (4) Segment  $B_2$ : it consists of consumers who are the switchers of brand 2 and have their reservation prices for brand 1 and brand 2 equal to  $L$  and  $M$ , respectively. The proportion of this segment is  $q/2$ . Let  $H > M > L > 0$  and  $0 \leq q \leq 1$ .

From the discussion in section 2, we know the competition among online retailers on the net is more intensive than the traditional channel in general. Thus, we assume there are two retailers  $R_1, R_2$  in the traditional channel, but there are many potential retailers on the Internet. Especially, only the retailers in the traditional channels have the ability to persuade consumers and change their preferences. A retailer can persuade consumers in  $B_1$  or  $B_2$  to buy their less preferred brand by incurring a persuasion cost  $C$  and raising their reservation price for their less preferred brand from  $L$  to  $M$ . In contrast, consumers in  $G_1$  and  $G_2$  can not be influenced by the retailer's persuasion effort. To highlight the importance of persuasion power of retailers at the traditional channels, we let  $L=0$ . After emergence of the Internet, a part of

consumers have the ability to shop on the net. Let  $\alpha_G$  and  $\alpha_B$  be the proportions of the Internet users in the segment of loyalists and in the segment of switchers, respectively.

The sequence of the game can be described as follows. First, the two manufacturers simultaneously decide which distribution channel(s) to use. Then they simultaneously choose only one retailer to sell their product for each chosen distribution channel. Then the contacted retailers accept or reject manufacturers' offers. Whenever the two manufacturers choose the same retailer to distribute their products, the common dealership occurs; otherwise, manufacturers adopt exclusive dealing. Then manufacturers set their wholesale prices and given the wholesale prices retailers set their retail prices.<sup>1</sup> As for the Internet channel, since there are many potential online retailers who will offer attractive contract in order to obtain the dealership from manufacturers. As a result, the retailer who gets the dealing right can not charge any retail price higher than its marginal price.

Denote the cost of setting up a retail outlet in the traditional channel by  $K_T$  and on the Internet by  $K_E$ .  $R_1$  and  $R_2$  set retail prices  $P_1, P_2$  given the wholesale prices  $w_1$  and  $w_2$ , and decide whether to influence a consumer's purchase decision by incurring a persuasion cost  $C$ . Besides, online retailers persuade consumers, which implies that the persuasion cost on Internet is assumed to be infinite.

Before shopping, consumers know the selling prices and their reservation prices of the two brands, and they seek to maximize their consumer surplus when choosing the product to buy. Consumers make their brand choice on the point of sales, which may be influenced by the retailer they shop at. To focus on the impact of the Internet on manufacturers' channel strategies, we deliberately abstract from the effect of consumer's differing preferences towards different distribution channels by assuming that the shopping cost of consumers at traditional channels is the same as on the Net and is equal to 0.

In what follows we use  $(X^i, Y^j)$  to denote an equilibrium where X-type consumers are served in the traditional channel and Y-type consumers are served on the Internet and  $i$  ( $j$ ) indicates the type of dealership adopted in the traditional channel (Internet channel, respectively), either exclusive dealing (denoted by E) or common dealing (denoted by C).

The game proceeds as follow:

1.  $N_1, N_2$  choose exclusive dealing or common dealing.
2. After the determination of channel structure,  $N_1, N_2$  set wholesale price  $w_1, w_2$ .
3.  $R_1, R_2$  set retail price  $P_1, P_2$ .
4. Consumers choose shopping channel

<sup>1</sup> This formulation is similar to that of Lin [4] and O'Brien & Shaffer [8.]

5. The retailer chooses whether to persuade.
6. Consumers choose brand.

### Before the emergence of Internet

Before the emergence of the Internet, the manufactures have to decide whether to distribute their product through the same retailer (i.e., common dealing) or different retailers (i.e., exclusive dealing), and which segments of consumers to target. Through exclusive dealing, manufactures are able to avoid the intensive price competition resulting from the retailer's incentive problem. Through common dealing, manufacturers can share the setup cost. Since manufactures are symmetric in every aspect, the equilibrium is also symmetric. The four possible equilibria are as follows:

1. Equilibrium ( $G^C, 0$ ): Both manufacturers only serve their respective loyals through a common retailer ( $N_1 \rightarrow (G_1, 0)$ ;  $N_2 \rightarrow (G_2, 0)$ ).

In equilibrium, the wholesale prices are set at the loyals' reservation price  $H$ , and so are the retail prices. In the equilibrium, the loyals' consumer surplus is completely extracted as in the monopoly case. The total channel profits are accrued to the manufacture and equal to  $\pi_1^M = \pi_2^M = M - (1 - q)H / 2 - K_T / 2$ .

2. Equilibrium ( $A^C, 0$ ): Both manufacturers serve all consumers in their respective markets through the common retailer ( $N_1 \rightarrow (G_1 + B_1, 0)$ ;  $N_2 \rightarrow (G_2 + B_2, 0)$ ).

First note that in order to induce the retailer to serve all consumers in manufacturers' respective market by setting the retail price at  $M$ , manufacturers would set their wholesale prices satisfying  $(M - w) / 2 \geq (1 - q)(H - w) / 2$ . The condition ensures that the retailer obtains higher profits when serving each manufacturer's switchers than otherwise. When this is the equilibrium,  $w_1 = w_2 = [M - (1 - q)H] / q$ .

Now we need identify the condition under which it is not profitable for each manufacturer to attract its rival's switchers by lowering its wholesale price and thus sustain the above equilibrium. To this end, we shall first derive the wholesale price that induces the retailer to switch consumers for the deviating manufacturer and then show that the resulting manufacturer profit is lower than staying in the equilibrium. When one manufacturer, say  $N_1$ , deviates by lowering  $w_1$ , the condition,  $(1 + q)(M - w_1) / 2 + (1 - q)[M - (M - (1 - q)H) / q] / 2 - C \geq (M - w_1) / 2 + [M - (M - (1 - q)H) / q] / 2$ , must be satisfied in order to induce the retailer to incur a cost  $C$  and persuade manufacturer 2's switchers to buy brand 1. Thus manufacturer 1 has to lower his wholesale price until  $w_1 = [M - (1 - q)H - 2C] / q$  in order to induce the retailer to switch his rival's consumers to buy brand 1. Finally, manufacturer 1 would prefer staying in the equilibrium to deviating if the condition,  $[M - (1 - q)H] / 2q \geq (1 - q)[M - (1 - q)H - 2C] / 2q$

$$(3-1)$$

holds. Simplifying the above inequality gives us:

$$C \geq [qM - q(1 - q)H] / 2(1 + q)$$

By (3-1), when the persuasion cost is high enough, both manufacturers will be content with their own customers, making it possible to sustain the equilibrium ( $A^C, 0$ ), the manufacturer's profits in this equilibrium are  $\pi_1^M = \pi_2^M = M - (1 - q)H / 2q - K_T / 2$ . When condition (3-1) does not hold, once the manufacturers choose the same retailer, they will compete with each other on the basis of the wholesale prices to obtain the retailer's support, as will be shown in the fourth possible equilibrium.

3. Equilibrium ( $A^E, 0$ ): Both manufacturers serve all consumers in their respective markets through their own exclusive retailer ( $N_1 \rightarrow (G_1 + B_1, 0)$ ;  $N_2 \rightarrow (G_2 + B_2, 0)$ ).

When each manufacturer serves consumers through their exclusive retailer, he does not need to worry about the retailer's persuasion power. Therefore, his pricing strategy is the same as in the monopoly case with the wholesale price equal to  $w_1 = w_2 = [M - (1 - q)H] / q$ .

4. Mixed strategy equilibrium: both manufacturers mixed pricing strategy through common dealing

When (3-1) does not hold, for example, when the proportion of switchers ( $q$ ) is high or/and the persuasion cost is low enough neither manufacturer will content himself with serving his own customers. Each manufacturer would like to attract his rival's switchers through the retailer's persuasion power by offering a more attractive wholesale price to the retailer, thus resulting in a severe price competition between manufacturers. On the other hand, each manufacturer can guarantee a marginal profit  $(1 - q)H / 2$  by serving his own loyals only. Thus the manufacturer will not cut his price lower than  $(1 - q)H / (1 + q)$  to attract his rival's switchers for in the latter case the resulting manufacturer profits  $[(1 - q)H / (1 + q)] * (1 + q) / 2$  are lower than in the former case. In fact, in the same spirit of Varian [9] and Narasimhan [7], there exists only the mixed strategy equilibrium where each manufacturer randomizes his wholesale price according to a distribution function. The manufacturer whose wholesale price turns out to be more attractive would succeed in obtaining the retailer's support in attracting his rival's customers for him. In this mixed strategy equilibrium, the expected profits for each manufacturer are  $\pi_1^M = \pi_2^M = (1 - q)H / 2 - K_T / 2$ , the same as the manufacturer would obtain by serving his loyals only.

Proposition 1: Let the reservation price of the loyals' be 1 and that of the switchers' be  $k$  ( $0 \leq k \leq 1$ ). Suppose that the setup cost in the traditional channel is the same as on the Internet, i.e.  $K_T = K_E = K$ .

Before the emergence of the Internet, the respective conditions for each equilibrium to occur are as follows:

Equilibrium	Equilibrium conditions
$(G^C, 0)$	$k \leq 1 - q^2$
$(A^C, 0)$	$k \geq 1 - q^2$ ; $k \leq [q(1 - q) + 2(1 + q)C] / q$
$(A^E, 0)$	$k \geq 1 - q^2 + Kq$ ; $k \geq [q(1 - q) + 2(1 + q)C] / q$
Mixed strategy equilibrium	$1 - q^2 \leq k < 1 - q^2 + Kq$ ; $k \geq [q(1 - q) + 2(1 + q)C] / q$

Table 1 The equilibrium conditions before the emergence of the Internet

The conditions above are derived from the following logic. To sustain equilibrium, the equilibrium profits have to be larger than any other profits that are derived from other possible strategies. Take equilibrium  $(A^C, 0)$  as an example. When manufacturers are in this equilibrium, they have no incentives to serve their respective loyals and to induce the retailer to persuade consumers to buy his brand. The former condition is equal to satisfy  $k \geq 1 - q^2$ , and the later condition is equal to satisfy  $k \leq [q(1 - q) + 2(1 + q)C] / q$ . As a result, the two inequalities are the conditions to sustain equilibrium  $(A^C, 0)$ . We can infer other equilibrium conditions by the same logic.

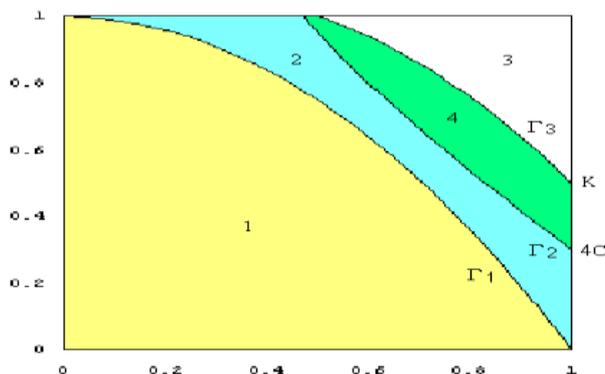


Figure 1 The equilibriums before the emergence of the Internet

Note:  
 1: Equilibrium  $(G^C, 0)$ ;      2: Equilibrium  $(A^C, 0)$ ;  
 3: Equilibrium  $(A^E, 0)$ ;      4: Mixed Equilibrium  
 $\Gamma_1$ :  $k = 1 - q^2$   
 $\Gamma_2$ :  $k = [q(1 - q) + 2(1 + q)C] / q$   
 $\Gamma_3$ :  $k = 1 - q^2 + Kq$   
 X-axis: q; Y-axis: k

By Figure 1, it is easy to show that which equilibrium happens depends on the switchers' value. When there are more switchers in the market or their reservation price is higher, we can say the switcher is more valuable. When the switcher is not so valuable, manufacturer wants to set the highest wholesale price  $H$  to serve the loyals only, it leads to equilibrium  $(G^C, 0)$ . When the switcher's value is higher but not too high, manufacturers have the incentives to serve all his own consumers but not the rival's switchers, so they can share a retail outlet peacefully and it is the equilibrium  $(A^C, 0)$ . When the switcher's value is too high, if manufacturers choose a common retailer, both of them can not satisfy with serving their own customers only, and it means they will have more intensive price competition. Thus, they are will to have more setup cost to avoid such price competition.

### After the emergence of the Internet

After the emergence of the Internet, two things are different from before. First, manufacturers can sell products through the Internet channel where retailers have much less influence on consumers' preference than in the traditional channel. Second, as mentioned in the model, not all consumers can access the Internet and thus the proportions of the Internet users in the segment of loyals (denoted by  $\alpha_G$ ) and in the segment of switchers (denoted by  $\alpha_B$ ) would determine the structure of the consumer market and hence the manufacturer's optimal channel strategy. The following lemma shows that manufacturers will choose common dealing whenever they sell products on the Net.

The problems facing each manufacturer include whether to sell his product through the traditional channel, the Internet channel or both, for each distribution channel whether to choose the common dealing or exclusive dealing, and whether to serve his loyals only or switchers as well. There are eight possible symmetric pure strategy equilibriums when manufacturers can distribute their products either through the traditional channel or the Internet channel. We describe them in the following.

1. Equilibrium  $(G^C, 0)$ : both manufacturers only serve the loyals in the traditional channel through common dealing ( $N_1 \rightarrow (G_1, 0)$ ;  $N_2 \rightarrow (G_2, 0)$ ).
  2. Equilibrium  $(A^C, 0)$ : both manufacturers serve all consumers in the traditional channel through common dealing ( $N_1 \rightarrow (G_1 + B_1, 0)$ ;  $N_2 \rightarrow (G_2 + B_2, 0)$ ).
  3. Equilibrium  $(A^E, 0)$ : both manufacturers serve all consumers in the traditional channel through exclusive dealing ( $N_1 \rightarrow (G_1 + B_1, 0)$ ;  $N_2 \rightarrow (G_2 + B_2, 0)$ ).
  4. Equilibrium  $(0, G^C)$ : both manufacturers only serve their loyals on the Internet through common dealing.
- In the above equilibrium, manufacturers set the wholesale prices at the loyals' reservation price  $H$  and so

do retailers set the retail prices. The profits of manufacturers are  $\pi_1^M \pi_2^M = (1-q) L H / 2 - K_E / 2$ .

5. Equilibrium  $(0, A^C)$ : both manufacturers serve all consumers on the Internet through common dealing. Because the retail market on the Internet is competitive, retailers can not charge any price higher than their marginal cost, i.e., the wholesale price charged by the manufacturers. As a result, the manufacturer can serve all consumers who can access the Internet in his protected market by setting his wholesale price at the switchers' reservation price  $M$ . The profits of manufacturers equal  $\pi_1^M \pi_2^M = (1-q) L q_s M / 2 - K_E / 2$ .

6. Equilibrium  $(G^C, A^C)$ : both manufacturers sell their products through the two distribution channels under common dealing. The manufacturers induce all their customers who can access the Internet to buy their products on the Net and serve their loyals who can not access the Internet in the traditional channel.

In equilibrium  $(G^C, A^C)$ , each manufacturer would like to serve his switchers on the Net and thus sets his wholesale price at  $M$ . Given this wholesale price, the online retailer would set the retail price also at  $M$  (again because of competition) while the traditional common retailer would set the retail price at  $H$ . Facing the two different retail prices, all consumers who can access the Internet would buy their preferred brand on the Net by paying a cheaper price and only the loyals who can not access the Internet buy their preferred brand from the traditional retailer. The manufacturer's profits are  $\pi_1^M \pi_2^M = (1-q) q_s M / 2 - (K_T + K_E) / 2$ .

7. Equilibrium  $(A^C, A^C)$ : both manufacturers sell their products through the two distribution channels under common dealing. The manufacturers induce all their customers who can access the Internet to buy their products on the Net and serve their remaining customers in the traditional channel.

When the consumers who can access the Internet are induced to the Net, the structure of remaining consumers in the traditional channel would change. To serve all consumers that stay in the traditional channel, the manufacturers would set their wholesale prices at  $M - (1-q)(1-\alpha_G)(H-M) / q(1-\alpha_B)$  to ensure the common retailer the same profits as those when serving the loyals only. This wholesale price is positively related to  $\alpha_G$  and negatively related to  $\alpha_B$ . With the similar reasoning used in deriving (2-1), we can derive the following lower bound for the retailer's persuading costs in order to sustain the equilibrium:

$$C \geq \frac{q^2(1-\alpha_B)^2 M - q(1-q)(1-\alpha_B)(1-\alpha_G)(H-M)}{2(1-q)(1-\alpha_G) + 4q(1-\alpha_B)} \quad (3-2)$$

8. Equilibrium  $(A^E, A^C)$ : serve all consumers with

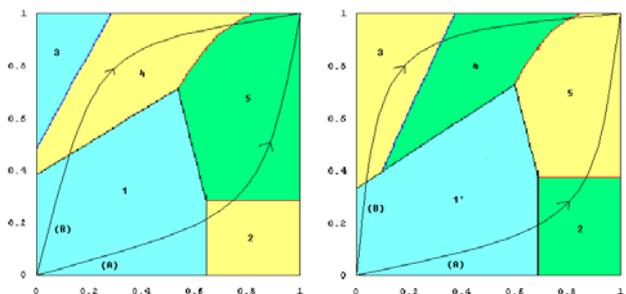
common dealing on the Internet and with exclusive dealing in the traditional channel.

If (3-2) is not satisfied, it means that when manufacturers adopt the strategy  $S(A^C, A^C)$ , they would have incentives to attract the competitor's switchers through the retailer's persuading, thus breaking the equilibrium  $(A^C, A^C)$ . When the proportion of the loyals who can access the Internet is higher than that of the switchers, inducing all Internet users to buy on the Net would lead the proportion of the switchers in the traditional channel relative to that of the loyals increases. Therefore, if manufacturers choose  $S(A^C, A^C)$ , manufacturers would compete aggressively on their wholesale prices with the hope that the common retailer can attract their rival's switchers for them. To avoid such competition, manufacturers may choose exclusive dealing in the traditional channel, resulting in the equilibrium  $(A^E, A^C)$ .

Proposition 2: Let the reservation price of the loyals be 1 and that of the switchers' be  $k$  ( $0 \leq k \leq 1$ ). Suppose that the setup cost in the traditional channel is the same as that in the Internet channel, i.e.,  $K_T = K_E = K$ . After the emergence of Internet, the conditions for equilibrium  $(G^C, 0)$  to occur are as follows:<sup>2</sup>

Follow the same logic as in proposition 1. When an equilibrium is sustained, the profits derived from other strategies are always less than the equilibrium profits. Take equilibrium  $(G^C, 0)$  as an example. A manufacturer has five possible alternative strategies. One is to serve all consumers in the traditional channel; two is to serve the loyals on the net; three is to serve all consumers on the net; four is to serve the loyals in the traditional channel and all consumers on the net; five is to serve all consumers in both channel. Compare the equilibrium profits with others derived from these strategies, and then we can get the inequalities stated in proposition 2.

$$1 - q \leq k - 1 - q^2 \quad k \geq 1 - q^2 \text{ \& } k \leq [q(1+q) + 2(1-q)q] / q$$



<sup>2</sup> Because of the page limitation, we do not list these conditions here.

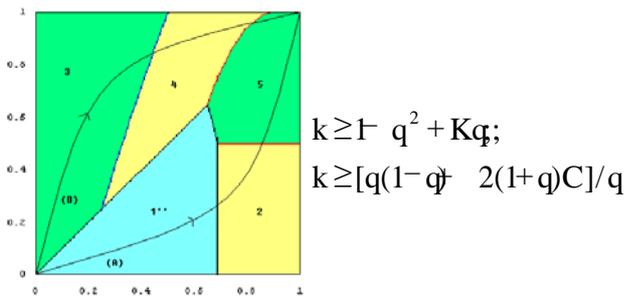


Figure 2 The equilibrium after the emergence of the Internet

Note:

1. Equilibrium: 1:  $(G^C, 0)$ ; 1':  $(A^C, 0)$ ; 1'':  $(A^E, 0)$ ; 2:  $(G^C, A^C)$ ; 3:  $(A^E, A^C)$ ; 4:  $(A^C, A^C)$ ; 5:  $(0, A^C)$
2. X-axis:  $\alpha_B$ ; Y-axis:  $\alpha_G$
3. Path A: more switchers can access the Internet than the loyals;  
Path B: more loyals can access the Internet than the switchers
4. Parameter value:  $k=0.35, 0.4, 0.8$  (from left to right);  $q=0.8$ ;  $C=0.05$ ;  $K=0.05$

Corollary 2-1: Keep the preferences and proportions of the loyals and the switchers constant. Suppose that the proportion of consumers who are able to access the Internet increases over time. Then the manufacturers' equilibrium distribution strategy will be dynamically adapted to the proportions of Internet loyals and Internet switchers.

Keeping other parameters constant, figure 2 shows that how the manufacturers' equilibrium distribution strategy varies with  $\alpha_G$  and  $\alpha_B$ . Before the emergence of the Internet (or equivalently, when both  $\alpha_G$  and  $\alpha_B$  equal zero), depending on the importance of switchers (represented by the size of  $k$ ) and the retailer's persuasion cost, the equilibrium could be  $(G^C, 0)$ ,  $(A^C, 0)$  or  $(A^E, 0)$ , which correspond to equilibrium 1, equilibrium 1' and equilibrium 1'' in the three graphs, respectively. With the increase in the proportion of Internet users, the equilibrium distribution strategy will be dynamically adjusted. The way in which the equilibrium distribution strategy adjusted crucially depends on the relative sizes of  $\alpha_G$  and  $\alpha_B$ . Two cases can be distinguished: the case where  $\alpha_G \leq \alpha_B$ , and the case where  $\alpha_G \geq \alpha_B$ .

In the case where  $\alpha_G \leq \alpha_B$ , as shown by the path A

in figure 2, with the emergence of the Internet, the distribution equilibrium may change from equilibrium  $(A^E, 0)$  into  $(G^C, A^C)$  as long as  $\alpha_B$  is high enough relative to  $\alpha_G$ . The manufacturer by expanding into the Internet channel, can induce a relatively higher proportion of switchers to buy his product on the Net, which enables him to serve only the loyal non-Internet users in the traditional channel and thus do not need worry about the traditional retailer's incentive problem of switching his customers. When  $\alpha_B$  is high enough relative to  $\alpha_G$ , the benefit from alleviating the retailer's incentive problem will outweigh the loss of the non-Internet users in the segment of switchers, thus leading to the equilibrium  $(G^C, A^C)$ . As more and more consumers can access the Internet,  $(0, A^C)$  becomes the equilibrium strategy.

In the case where  $\alpha_G \geq \alpha_B$ , as shown by the path B in figure 2, with the emergence of the Internet and the increase in the proportion of the Internet users, the distribution equilibrium may change from equilibrium  $(A^C, 0)$  first into  $(A^E, A^C)$ , and finally into  $(A^C, A^C)$  as long as  $\alpha_B$  is high enough relative to  $\alpha_G$ . The manufacturer by expanding into the Internet channel, can induce a relatively higher proportion of loyals to buy his product on the Net, which aggravates the retailer's incentive problem of stealing customers but mitigating the manufacturer's concern for double-marginalization. The latter benefit will outweigh the former cost when  $\alpha_B$  is small enough relative to  $\alpha_G$ , thus resulting in the equilibrium  $(A^E, A^C)$ . In other words, the manufacturer uses exclusive dealing to overcome the traditional retailer's incentive problem and alleviate the double-marginalization problem by mitigating loyals to the Internet channel. When the proportion of Internet users in the segment of switchers keeps increasing, it becomes less desirable for either manufacturer to induce the retailer to persuade customers and hence the equilibrium changes into  $(A^C, A^C)$ . As more and more consumers can access the Internet,  $(0, A^C)$  becomes the limiting equilibrium.

Corollary 2-2: Whether common dealing becomes more prevalent after the emergence of the Internet crucially depends on the structure of the consumer market, in particular, the importance of loyal switchers, and the proportions of Internet users in the segment of loyals and in that of switchers ( $\alpha_G$  and  $\alpha_B$ ).

1. If  $k \geq 1 - q^2 + Kq$  and  $k \geq [q(1-q) - 2(1+q)C]/q$  common dealing becomes more prevalent in the presence of the Internet channel;
2. If  $1 - q \leq k - 1 - q^2$  or  $1 - q^2 \leq k - [q(1-q) + 2(1+q)C]/q$ , exclusive becomes more prevalent only if  $\alpha_G$  is extremely high relative to  $\alpha_B$ ;
3. If  $k \leq 1 - q$ , manufacturers prefer common

dealing to exclusive dealing both in the absence and in the presence of the Internet channel.

Proof. The above corollary is derived by comparing the equilibria before the emergence of the Internet channel with those after.

## References

- [1] Bakos, Yannis J. (1997), "Reducing Buyer Search Costs: Implications for Electronic Marketplaces," *Management Science*, Vol. 43, No. 12, pp. 1676-1692.
- [2] Brynjolfsson and Michael D. Smith (2000), "Frictionless Commerce? A Comparison of Internet and Conventional Retailers," *Management Science*, Vol. 46, No. 4 (April), pp. 563-585.
- [3] Lal, Rajiv and Miklos Savary (1999), "When and How is the Internet Likely to Decrease Price Competition," *Marketing Science*, Vol. 18, No. 4, pp.485-503.
- [4] Lin, Y. J. (1990), "The Dampening-of-Competition Effect of Exclusive Dealing," *Journal of Industrial Economics*, 39, pp.209-223.
- [5] Marvel, Howard P. (1982), "Exclusive Dealing," *Journal of Law and Economics*, Vol. XXV (April), pp. 1-25.
- [6] Mathewson, G Frank and Ralph A. Winter (1987), "The Competitive Effects of Vertical Agreements: Comment," *The American Economic Review*, pp. 1057-1062.
- [7] Narasimhan, Chakravarthi (1988), "Competitive promotional strategies," *The Journal of Business*, Vol. 61, Iss. 4, pp. 427-49.
- [8] O'Brien, Daniel P. and Greg Shaffer (1993), "On the Dampening-of-Competition Effect of Exclusive Dealing," *The Journal of Industrial Economics*, Vol. XLI (June), pp. 215-221.
- [9] Varian, Hal R. (1980), "A model of sales," *The American Economic Review*, Vol. 70, Iss. 4; pg. 651

# Bidding Behavior on Internet Auction : Secondhand versus Newly Manufactured Products

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## Abstract

Although auctions have been an important model for price discovery on Internet, economics does not have a precise theory of auctions. Auctions raise many problems such as what types of goods will be sold by auction on Internet, and how bidders bid on Internet auction. It is curious why some newly manufactured products that are sold on the posted-price markets are also sold by auction on Internet. This paper presents a field study on Internet to investigate the differences between the bidding behavior for secondhand and newly manufactured goods. Data is collected on an open-book auction site. The results show that there were really some bidders behaved like evaluators and whether a bidder will be an evaluator or a participator is not affected by common referenced external market price. Furthermore, the prices on posted-price market may affect bids on the auction market., averaged normalized mark up of newly manufactured items were significantly larger than that of secondhand items. Implications of the findings are also discussed in this paper.

## 1. Introduction

The Internet is shaping industries and changing business models. Internet can facilitate transactions between buyer and seller and lower the transaction cost. Some literatures suggested that Internet will cause the disintermediation effects and network services will replace traditional middlemen in the value chain [14] [16]. The issue of disintermediation has raised the debates on whether electronic marketplace can perform the functions of traditional middleman [1].

One major function of intermediaries is to gather, organize, and evaluate information, which is dispersed in society, and to set the price based on this information to clean the market [18] [20]. It is a hard work for the firms to get sufficient information to make the pricing decision. So usually either the quantity of demand is less than the quantity of supply and the product has to be sold at a discount, or the posted price is too low and there will be a rush for the product or the buyers have to pay a premium. Because it is not easy to clean the market on the posted price, traditionally, except for the transactions of some standardized commodities in retail market, most of the final dealing prices are decided by dickering or

bargaining. The price marked in the store or printed in the catalog is just the asking price of the seller. This asking price is usually higher than the price the seller can accept. Sellers and buyers will try to gather information and reveal the other's bottom line during the bargaining process.

For the posted price is usually not efficient enough, it is an interesting problem how the price is decided for products sold on Internet. Lower menu cost is one major benefit of electronic commerce [19]. Modahl [13] has suggested that the dynamic pricing model, which can change the price simultaneously according to current sales, is the most important innovative feature of electronic commerce. On the other hand, some bargaining agents, which is a software agent on the Internet and can take the place of seller or buyer in the bargaining processes, have been proposed [8]. However, although there have been so many solutions for price discovery, auction is still the seldom one which has worked in practice. Electronic auction solve the problem of getting the buyers or sellers to reveal their best price. Companies such as eBay, Ubid, Priceline, and FreeMarkets have invented various auction models in different markets and worked well. For example, eBay, which provides a platform for English auction for individual sellers and buyers, has supposed to be one of the most successful companies on Internet.

Although auctions have been an important model on Internet, economics does not have a precise theory of auctions [4]. Firms face the new type of transaction need to learning how to adopt the new mechanism in the organizations as sellers or buyers [3] [5]. Because Internet provides a different context for auction, bidding behaviors on Internet may be different from other auction markets. Internet auctions raise a variety of interesting questions for economists to investigate such as what types of goods will be sold by auction, and how bidders bid on Internet auction. It is curious why some newly manufactured products that are sold on the posted-price markets are also sold by auction on Internet. This paper will present a field study on Internet that investigated the differences between the bidding behavior for secondhand and newly manufactured goods. Results of this study may help to find out how bidders bid on the Internet and facilitate to explain the utilization of auction on Internet.

## 2. Auctions on the Internet

Auctions are processes of formalized dickering. There have been many different auction mechanisms like the English ascending-bid auctions, the Dutch descending-bid auctions, the first-price sealed-bid auctions, the Vickrey second-price sealed-bid auctions and double auctions [12]. Auction could be an effective way for price discovery if the number of participants is large enough. However, the cost of gathering enough participants at the same time is high, so in the past, auctions are seldom used in consumer markets except for some expensive collectables.

Electronic auction solve the problem of getting the players at the same time to reveal their best price. Auction evolved in a setting where people could hear and see each other. Traditionally, people participate in an English or Dutch auction have to stay and pay attention to the process during the bidding period. But Internet has provided a different context. The network can get people in different locations participate the auction easily. Besides, in order to get more participants, auctions on the Internet are usually asynchronous that the auction information is exchanged on the network and the bidding period continues for a few days. The basic challenge for Internet auction is that bidders in an auction lasting for several days have to stay on line to raise their bids. Proxy bidding solves this problem by providing a software agent. When current price is below the upper limit price specified by the bidder, the agent will bid automatically on the price mark up by the minimum increment set by the seller [4]. So people don't have to stay on line and can bid on any convenient time during the auction period. Asynchronous auctions have lowered buyers' cost to participate.

Lee [7] analyzes prices in electronic and conventional auction markets for used cars sold from 1986 to 1995. He found that prices in the electronic markets were higher than prices in the conventional markets and that this price difference seems to increase over time. This result has showed that the electronic markets have been more efficient than conventional markets for auctions.

### 2.1 Types of goods

As Internet technology lowers the cost of running an auction relative to using other pricing mechanisms, it is expected that new types of goods will be auctioned. However, the literature has not yet examined the question of what types of goods sellers would prefer to auction [11]. Wang [21] compares posted-price selling with auctions and finds that without auction costs, auctions are always optimal, and as long as there is a wide dispersion of buyer valuation, auctions will still outperform posted-price selling even if auctions were costly [6]. Similarly, Hall [4] argues auctions are favored when there is a lot of uncertainty about the market value of the objects. The value has to be high enough to make the auction process worthwhile, and the players need to have

enough time to make the auction work.

For Internet technology lowers the costs of running an auction, Lucking-Reiley [11] suggests as the market develops out of its infancy, we might well expect to see more additions to the list of auctioned. On the other hands, Liebowitz [9] emphasizes auctions are a step backward in the evolution of retailing and only make sense for odd lots, surplus, one-of-a-kind items, or items for which the audience likes the thrill of the chase. Meanwhile, Lucking-Reiley [11] suggests that auctions will be used most often for goods in limited supply where the demand is unknown to the seller, because these are the circumstances under which the benefits of a flexible, market-determined price are likely to be greatest. Lucking-Reiley [11] also notices that auctions would seem to provide relatively little social benefit in the case of newly manufactured items, because the supply of such items is not fixed, so the retailer can adjust prices or quantities in response to observed demand. By contrast, used and rare items are in relatively fixed supply, so auctions can be valuable in determining the correct price and allocation in the face of uncertain demand.

However, many auction sites do sell newly manufactured items. Lucking-Reiley [11] notes that there have been two primary business models for Internet auctions: merchant sites and listing-agent sites. A merchant site offers its own merchandise for sale, acting as a retailer who happens to conduct its transactions through auction. A listing site acts as an agent for other sellers, allowing them to register their items and running the auctions on their behalf. Some auction sites combine both types of models. Many Products sold on the merchant sites are newly manufactured ones.

### 2.2 Bidding behavior

Why these newly manufactured products are sold by auction is an interesting question because these products are sold on posted-price in the past. It seems that the cost to adjust prices or quantities on posted-price markets is higher than the cost of auctions markets on Internet. However, efficiencies of auction markets are affected by numbers and strategies of bidders. Bapna et al. [2] studies bidders' strategies in multi-item online auction and the result of the data mining shows there are three types of bidders: evaluators, participators, and opportunists. Evaluators are those who know clearly their true valuation of the good and submit high bids at the early stages of the auction. Participators are bidders who follow the bidding closely and place ascending bids. Opportunists are driven by thoughts of getting bargains – they usually place the lowest possible bids toward the end of an auction. Because there are list prices for the newly manufactured products, which are also sold on posted-price market, if the posted prices are efficient enough, these prices will be the common value of the products. There will be more bidders who know the market value of the items and may behave like evaluators.

However, Hall [4] has told another story. He argues that auction theory is based on the idea that the players all have cutoff prices in mind before the auction begins. If all bidders are eventually going to enter bids with their true maximums, it just does not matter, whether you bid at the beginning, middle, or end of the auction, or when others bid, has no effect on the outcome. The winner is always the player with the highest cutoff price, and the price is always the runner-up maximum plus the bid increment.

In fact, there is lot evidence that people learn auctions and adjust their ideas about the value of what is for sale. Bidders learn about the value of the goods by seeing the bids of others. They don't know their cutoff values before an auction begin [12]. Rather than having a good idea of the maximum they are willing to pay, they have a general idea that they want an object, and a firm desire not to pay more than it is worth. They would like to gather information from others about an object's value. Hall [4] also suggests experts who know the value of the item will not bid until the end of the auction in order not to reveal the value and raise the price. This strategy is similar to the strategy of opportunists proposed by Bapna et al. [2].

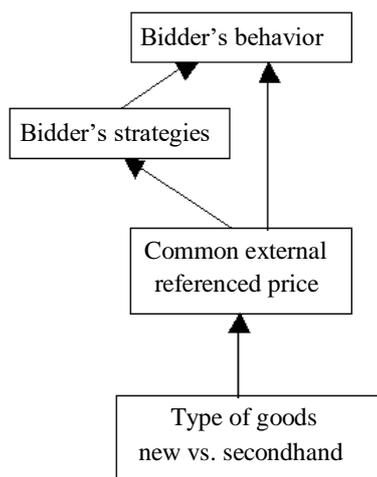


Figure 1. Theoretical model

Figure 1 illustrates the theoretical model of this study. Independent-private-value and asymmetries of information are two important assumptions of many auction theories [12]. For auctions of newly manufactured goods, Common external referenced price on the posted-price market will influence both the strategy and the behavior of bidders. Based on the classification of Bapna et al. [2], we propose that the bidding behaviors for secondhand products will be different with bidding behaviors for newly manufactured ones, and we conducted a field to verify the differences

### 3. Research Context

We got more than one hundred auction sites using two Chinese search engines. However, as mentioned by Lucking-Reiley [11], most of these auction sites were relatively small. This result reflects the network externality effects of auctions [6]. The site Go2HK (www.go2hk.com) was selected as the sample among the auction sites being searched for several reasons. First, comparing with other auction sites been searched, there were more buyers and products being sold on this site, so auctions on the site would be more likely to be efficient. Second, the site followed the rule of English auction, which is the most popular mechanism on Internet auctions. Third, both secondhand and newly manufactured items were sold on Go2HK, hence this site satisfied the requirements of our study. Fourth, auctions on this site were open-book ones, details of the auctions such as the buyer, price, and time of each bid were provided, and so behaviors of the bidders can be observed.

Lucking-Reiley [11] has surveyed types of items at auction on Internet and finds that the collectibles and the electronics and computers were the two most popular ones. Although collectibles was the largest category, transactions of electronics and computers were selected as the subjects of this study because electronics and computers were more standardized product. For the same reason, the study focused only on transactions of notebook computer and mobile phone.

Go2HK followed the rule of English auction. English ascending-bid auctions are by far the most prevalent on the Internet. On Internet English auction, bidders can search the items they are interested, view the current high bid, and decide whether to raise the bid price. In order to ensure the efficiencies, mark up of the bid must bigger than the minimum acceptable increment set in advance. The process will continue to the end of the bidding period. The last bidder, who will pay the highest price, is going to win the auction. Go2HK also provided the service of proxy bidding. A bidder with a high willingness to pay need not check back at the site repeatedly to keep raising the bid as necessary. Using proxy bidding, it will be no differences when the bidders propose their rules, the bidder with the highest upper limit price will always win the bid, and the price he pay will equal to the price of the next highest upper limit price add on the minimum acceptable increment. From the perspective of auction theory, results of proxy bidding are similar to the sealed-bid, second-price Vickrey auction [10].

Data are collected from the auction site Go2HK. Although there were many items been sold on this auction site, most of them got few responses. Because the interactions among bidders should affects bidding behavior, only the bidding records of the auctions with more than ten bids were collected. 41 auction items that terminate in the data collecting period and satisfied the criteria of bids number and were got. There were totally

1449 bids in the 41 auctions. Table 1 and table 2 show the components of the auction items and bidding records collected in the sample.

Table 1. Auction items in the sample

	Mobile phone	Notebook computer	Total
Newly manufactured items	7	6	13
Secondhand items	12	16	28
Total	19	22	41

Table 2. Bidding records in the sample

	Mobile phone	Notebook computer	Total
Newly manufactured items	223	239	462
Secondhand items	340	647	987
Total	563	886	1449

#### 4. Analysis

Bidding Strategies of evaluators are different with the strategies of participators. Evaluators know clearly their true valuation of the good and submit high bids at the early stages of the auction. On the other hand, Participators are bidders who follow the bidding closely and place ascending bids. So in English auction, participators will bid on the mark up equal to the minimum acceptable increment, and evaluators may bid on the mark up larger than the minimum increment. Comparing with the auctions of secondhand items, because there are the referenced external market prices for the newly manufactured items, bidders can more easily evaluate the true value of the item and are more likely to become evaluators. So there will be more bids which on the mark up larger than the minimum increment for the auctions of newly manufactured items.

Existence of evaluators is discussible. Even if bidders may know the value of the item been auctioned, they will avoid to reveal their valuation and try to get the item on the price as low as possible [4]. Especially by using proxy bidding, bidders can easily bid incrementally and try not to reveal their highest prices. Although there are external market prices of newly manufactured items, bidders will behave like participators and bidding behaviors of newly manufactured items will not be different with that of secondhand ones.

Table 3. Percentage of bids on mark up larger than minimum increment

	Mobile phone	Notebook computer
Newly manufactured items	19.91%	25.75%
Secondhand items	24.09%	17.12%

Table 3 presents the percentage of bids on mark up larger than minimum acceptable increment for each type of items. The table shows that, first, about one fifth to one fourth bidding bided on mark up larger than the minimum acceptable increment, there were really some bidders behaved like evaluators. And second, percentages of bids that on mark up larger than the minimum increment on secondhand items were not different with that on newly manufactured items. The results indicate that there is really someone who will behave like an evaluator on Internet auction, and whether a bidder will be an evaluator or a participator is more likely to be affected by some factors of personal characteristics, but not the factors such as common referenced external market price.

Although the external market price would not affect whether the bidders will be evaluator or participator, it is still interesting whether the external market price could make any impact on bidders' behavior. If there are not any effects at all, the reason could be that the market price is not an efficient one. Except for comparing the percentages of bids of which on the mark up larger than the minimum increment, average mark up are also compared in the study. Because for different items, the price levels were not the same, mark up is normalized by divided by the minimum acceptable increment. Formula of normalizing mark up is as follow:

$$q_i = (P_i - P_{i-1}) / P_{min} \quad (1)$$

$q_i$  : normalized mark up for the  $i$  bid,

$P_{min}$  : minimum acceptable increment,

$P_i$  : price for the  $i$  bid.

Table 4. Averaged normalized mark up for mobile phone

	New mobile phone	Secondhand mobile phone
Average	25.072	2.264
Variance	15219.156	14.969
N	223	340
t statistics	3.4081	
p (two tails)	0.0007 < $\alpha=0.1$	

Table 5. Averaged normalized mark up for notebook computer

	New notebook computer	Secondhand notebook computer
Average	50.992	2.588
Variance	53796.41	935.655
N	239	647
t statistics	5.1923	
p (two tails)	2.5786E-07 $< \alpha = 0.1$	

Averaged normalized mark up prices for new manufactured and secondhand items is compared by t test separately for mobile phone and notebook computer on table 4 and table 5. The results indicate averaged normalized mark up of newly manufactured items were significantly larger than that of secondhand items, both for mobile phone and for notebook computer. Although external referenced price may not affect whether a bidder will be an evaluator or a participator, affected by the prices on posted-price markets as common referenced value, evaluators for the newly manufactured items will bid on a higher mark up than evaluators for the secondhand items.

## 5. Conclusion

We conducted a field study on Internet to investigate the differences between the bidding behavior for secondhand and newly manufactured goods. Data is collected on an open-book auction site that lists all the bidding history on web. Results of the analyses show that, first, there were really some bidders behaved like evaluators. Second, percentages of bids that on mark up larger than the minimum increment on secondhand items were not different with that on newly manufactured items. Whether a bidder will be an evaluator or a participator is more likely to be affected by some factors of personal characteristics, but not the factors such as common referenced external market price. Third, averaged normalized mark up of newly manufactured items were significantly larger than that of secondhand items, common external referenced price may affect bidders' behaviors.

This study try to investigate what types of goods will be auctioned on the Internet by comparing bidding behaviors of newly manufactured goods and that of secondhand ones. Results of the study suggest the prices on posted-price market will not affect bidder's strategy but could still affect bids on the auction market. Because bidders do refer to the posted-price, the problem why newly manufactured products are sold by auctions remains to be further investigated. Winner's curse of the auctions may be one of the reasons [15]. Except for the bidding price, bidding time is also an important decision

variable in auctions. Experts and opportunists will not bid until the last minute of the bidding [2] [4]. The last minute effect has been well-known phenomenon on Internet auctions [17]. Bidding time should be further combined with bidding price to model and compare the bidding behaviors of various types of goods.

This study verified bidders' strategies as evaluators and participators. However, it is still curious why bidders will be an evaluator that raise the prices substantially and reveal their valuations of the items, and why bidders as a participator will bid in the early stage of the bidding. Many works needed to be done in the future.

## Reference

- [1] Bakos, Y., "The Emerging Role of Electronic Marketplaces on the Internet," *Communications of the ACM*, Vol. 41, No. 8, August 1998, PP. 35-42.
- [2] Bapna, R., Goes, P. & Gupta, A., "A Theoretical and Empirical Investigation of Multi-item On-line Auction," *Information Technology and Management*, Vol. 1, No. 1-2, 2000, pp. 1-23.
- [3] Ertogral, K. & Wu, S. D., "Auction-theoretic Coordination of Production Planning in the Supply Chain," *IIE Transactions*, Vol. 32, 2000, pp. 931-940.
- [4] Hall, R. E., *Digital Dealing: How e-Markets are Transforming the Economy*, New York, NY: W. W. Norton & Company, 2001.
- [5] Jin, M. & Wu, S. D., "Supply Chain Coordination in Electronic Markets: Auction and Contracting Mechanisms," ISE Technical Report 00T-071, Lehigh University, November 2001.
- [6] Kauffman, R. J. & Wang, B., "New Buyers' Arrival Under Dynamic Pricing Market Microstructure: The Case of Group-Buying Discounts on the Internet," *Journal of Management Information Systems*, Vol. 18, No. 2, Fall 2001, pp. 157-188.
- [7] Lee, H. G., 1997. "Do Electronic Marketplaces Lower the Price of Goods," *Communications of the ACM*. Vol. 41, No. 12, January 1997.
- [8] Liang, T. P. & Doong, H. S., "Effect of Bargaining in Electronic Commerce," *International Journal of Electronic Commerce*, Vol. 4, No. 3, Spring 2000, pp. 23-43.
- [9] Liebowitz, S., *Re-thinking the Network Economy: The True Forces that Drive the Digital Marketplace*, AMACOM, 2002.
- [10] Lucking-Reiley, D., "Vickrey Auctions in Practice: From Nineteenth Century Philately to Twenty-first Century E-commerce," *Journal of Economic Perspectives*, Summer 2000, vol. 14, no. 3, pp. 183-192.
- [11] Lucking-Reiley, D., "Auctions on the Internet: What's Being Auctioned, and How?" *Journal of Industrial Economics*, Vol. 48, No. 3, September 2000, pp. 227-252.
- [12] McAfee, R. P., "Auctions and Bidding," *Journal of Economic Literature*, Vol. 25, June 1987, pp. 699-738.
- [13] Modahl, M., *Now or Never*, Forrester Research, 2000.
- [14] Malone, T. W.; Yates, J.; and Benjamin, R. I. *Electronic*

Markets and Electronic Hierarchies,” *Communications of the ACM*, Vol. 30, No. 6, June 1987, pp. 484-497.

[15] Mehta, K. & Lee, B., “An Empirical Evidence of Winner’s Curse in Electronic Auctions,” *Proceedings of the Twentieth International Conference on Information Systems*, 1999, pp. 465-471.

[16] Rayport, J. F. & Sviokla, J. J., “Exploiting the Virtual Value Chain,” *Harvard Business Review*, November-December 1995: 75-85.

[17] Roth, A. E. & Ockenfels, A., “Last Minute and the Rules for Ending Second-Price Auctions: Theory and Evidence from a Natural Experiment on the Internet,” Working paper #7729, National Bureau Of Economic Research, May 2000.

[18] Schmitz, S. W., “The Effects of Electronic Commerce on the Structure of Intermediation,” *Journal of Computer Mediated Communication*, Vol. 5, 2000, (<http://ecommerce.mit.edu/papers/ERF/ERF114.pdf>)

[19] Smith, M. D., Bailey, J. & Brynjolfsson, E., “Understanding Digital Markets: Review and Assessment,” in E. Brynjolfsson & B. Kahin eds., *Understanding the Digital Economy*, MIT Press, 1999.

[20] Spulber, D. F., *Market Microstructure – Intermediaries and the Theory of the Firm*, Cambridge University Press, 1999.

[21] Wang, R., “Auctions versus Posted-Price Selling,” *American Economic Review*, Vol. 83, No. 4, September 1993, pp. 838-851.

# Managing Changes in E-Transformation

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## Abstract

In today's digital economy and business, firms especially the SMEs (small and medium-sized enterprises) are facing competitive challenges from anywhere around the globe. Transforming the traditional business processes and activities into electronic capable (e-capable) format has become the essential tasks for companies to not only sustain in the competitive environment but flourish in the companies' perpetual operations. During the e-transformation process, organisations normally face changes in various aspects. To success in the transformation, companies need to manage the changes effectively. The change management tasks should be developed systematically through the identification of areas where changes may occur, and the research and development of solutions that will accommodate the changes.

This study proposes a conceptual model for managing changes in e-transformation, which provide SMEs with a methodological framework in identifying and managing organisational changes.

## 1. Introduction

Many firms especially the SMEs have recognised the information technology (IT) as the key driver that could enable companies to position themselves competitively into the global marketplace. Specifically, the Internet is a prominent medium for providing SMEs with a speedy transformation process that allows companies to transit their business activities and operations from a domestic focus to the global orientation. Nevertheless, transforming SMEs into e-businesses is not just creating interactive websites and incorporating payments as part of the online functions. The real challenges for companies pursuing e-transformation is to embrace the management of changes before, during, and after the transition in all aspects.

This study aims to development a framework for managing changes in e-transformation that would assist SMEs in strategic planning and decision making for the transition. The paper starts with the revisiting of SMEs e-transformation roadmap, review the forces to organisational change, followed by the identification of organisational changes in e-transformation. Finally, it concludes with the proposed framework for change management in e-transformation and the development of a checklist for e-transformation achievement.

## 2. The E-transformation Roadmap for SMEs

There is no doubt that many SMEs are eager to engage themselves in the e-business vogue through the application of the Internet technology which incorporates eminent and fascinating functionalities such as interactive or "full-duplex" communications, online payment, and dynamic inventory et cetera. Moreover, companies are commonly impatient to develop their "corporate websites" which contain typically the same information as they put in the Yellowpages and which is rarely updated. As the result of such unplanned approach, senior executives are most likely to diminish the budget and human resources involvement and eventually suspend the e-transformation project.

In order to successfully transform small and medium-sized firms into e-capable companies, Ginige et al. [1] proposed an e-transformation roadmap which focuses on not only the website development, but also the involvement of employees as individuals, project or task teams as groups, as well as the entire company as a single entity. The roadmap (Figure 1) consists of eight phases: basic website, interactive website, e-commerce website, effective individual, effective group, effective enterprise, convergence, and new emerging business processes. The first six phases of the roadmap are formed into internal and external development approaches. The internal development approach is mainly concerned with the transition of effectiveness with a company. It is constructed as of the development of effective individuals toward the effective enterprise. On the other hand, the external development approach is related to the construction of the website and its functionalities. It is based on the development of a static, information only website towards e-commerce, online payment competent website. Each e-transformation roadmap phase is briefly outlined in the following sections.

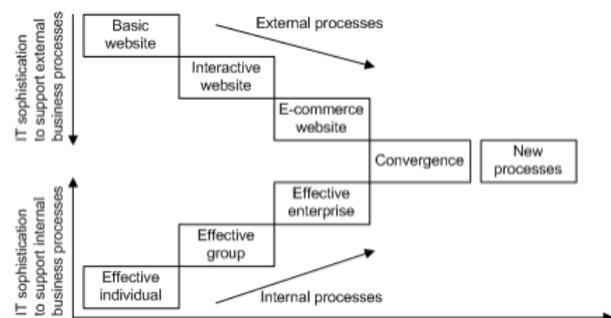


Figure 1. E-transformation roadmap for SMEs

## 2.1 Basic Website

It refers to a static, and information only website. This is a preliminary external development phase that enterprises use the Internet as the media for disseminating marketing and advertising campaigns and products information. In this phase, the Internet is employed as the same way as they have been using in the conventional promotion methods such as magazines, newspapers, and product catalogues and so on. The main task of this phase is to ensure the corporate web presence with the appropriate contents incorporated.

## 2.2 Interactive Website

In the second transformation phase, companies are suggested to construct their websites towards more advanced functions. This type of website can be seen as an interactive website which provide the browsers (eg. the clients/customers, or employees) with dynamic and up-to-date information. The key concept of the dynamic contents emphasises on the connection and interface between the front-end website and the back-end database systems. The initial task of an interactive website development is to identify what are the dynamic contents should be available on the Internet.

## 2.3 E-commerce Website

The ultimate e-transformation objective in regarding to the website evolution is to construct an e-commerce or online payment enabled website. Through an e-capable website, customers are able to place sales orders, organise accounts payables; vendors or suppliers are able to remit invoices and receive payments; and the enterprise could arrange payrolls and any other expenses. The imperative task in this phase focuses on the development of secure environment that provides all business parties confidently trading through the Internet.

## 2.4 Effective Individual

This phase refers to the initial stage for the internal approach of the e-transformation process. It is the fundamental phase that each employee should have suitable IT facilities that will support their individual needs to carry out daily business activities. The appropriate IT facilities support individuals including personal computers, laptops, word processing applications, and spreadsheets applications.

## 2.5 Effective Group

The second level of internal approach refers to the development of an effective group. Teamwork is an imperative concept in exploiting the diverse skills of individual employees and resulting efficient outcomes. Without a doubt, the IT and information systems are the keys to provide an effective team or group environment. The specific components in relation to IT and information systems comprise groupware applications (such as Lotus Notes® and Microsoft® Exchange Server), collaborative

software applications, project management applications and so forth.

## 2.6 Effective Enterprise

When moving from the effective group development towards an effect enterprise, the company needs to integrate and interconnect tasks performed by individuals and groups into a single entity. This requires supports from the adoption of network infrastructure, network operating systems, as well as the integration of information systems and the enterprise resource planning applications.

## 2.7 Convergence

Once the internal and external developments have reached the mature status – e-commerce website and effective enterprise stages, companies are competent to converge both internal and external into a single operation. That is, an enterprise's information system has the capability of obtaining information from the Internet, processing the information for specific needs, and remitting the processed information or results back to the Internet for other business parties (Figure 2). This would eventually lead to collaborative business.

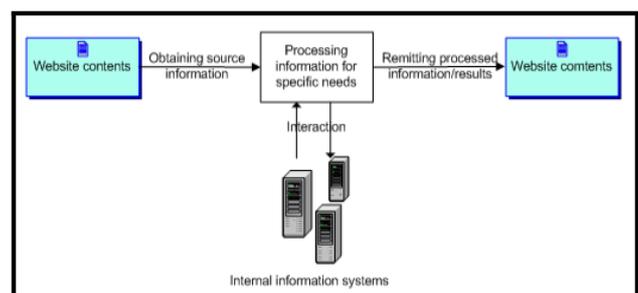


Figure 2. Internal and external convergence phase

## 2.8 New Business Processes

A number of new business processes are emerging as a result of the convergence phase. These new business processes generally relate to the activities of handling the business behaviours amongst business parties (clients, suppliers, and the enterprise itself). Such including customer relationship management (CRM), supplier relationship management (SRM), supply chain management (SCM), and knowledge management (KM).

## 3. Forces of Organisational Changes

Firms have realised that they have to make changes in order to transform themselves into e-capable enterprises. Before positioning themselves in the process e-transformation, they must clearly identify what are the driving forces for change. Because every business has different status and competencies, identification of the driving forces is essential to ensure the correct starting point of the e-transformation roadmap for each enterprise. Generally, the driving forces for change can be divided into two broad categories: external and internal.

### 3.1 External Forces

In this category, the forces for change come from outside of the company. This mainly refers to the business parties that are external to the business such as customers, suppliers, vendors, and competitors. In addition, political, economic climate [2] and certainly IT are also imperative external forces. All these external forces demand enterprises to make changes in order to sustain in the global competitive environment. Outcomes of the change generally result in reducing costs, increasing productivity and product quality, shortening distribution time, and applying IT for business operations.

### 3.2 Internal forces

The internal forces refer to the factors arise within the company. They are commonly related to changes in terms of the business development and growth. For example, in the transition of globalisation [3] enterprises are facing changes in organisational structure, reporting hierarchy, business vision and strategy.

## 4. Identification of Changes

After the investigation of each phase in the roadmap and the related driving forces, changes in e-transformation can be generally classified in five categories: business processes, applications, employee and skills, technology infrastructure, and executive management.

### 4.1 Business processes

Introduction or changes of business processes are required to

1. provide employees to perform their work effectively,
2. link or connect business functions together with an enterprise,
3. be able to share information between business parties,
4. enable website contents up-to-date,
5. allow website contents to be dynamically presented and accessed by the external users,
6. facilitate online transaction functions that are accessed and trusted by the external users, and
7. integrate the internal information systems and external website functions to handle e-commerce related business operations.

### 4.2 Applications

Introduction or changes of software applications are required to

1. carry out essential industry specific needs,
2. allow employees to communicate each other and transfer messages within an enterprise such as email applications,
3. facilitate the ability of information sharing for business purposes, for example, project

management and scheduling applications, groupwares, and intranet systems,

4. accomplish the implementation of new emerging business processes (CRM, SRM, SCM, and KM),
5. retrieve the company's website which contains static company and product information, messages for the external users, mailing lists, and frequent asked questions session (FAQs),
6. access the company's interactive website which contains dynamic product information (inventory in particular), interactive enquires and feedbacks, discussion boards, member login facility, and
7. provide online web functions for placing orders, tracking orders or delivery schedules, online payment, and distributing electronic products and services.

### 4.3 Employee and skills

Introduction of new skills for appropriate employees are essential to

1. implement basic computer applications such as word processors, spreadsheet applications, and industry specific software packages,
2. carry out work related tasks through the utilisation of computer applications for communicating within team and project environment, such as the skills of using project management software, email applications, groupwares, and accessing databases,
3. gain competency in implementing enterprise wide information systems such as enterprise resource planning (ERP), CRM, SRM, and SCM applications,
4. browse websites for searching work related information from the Internet,
5. handle interactive website functions such as responding online enquires, posting news and messages for discussion forums, updating and accessing product information dynamically, and
6. perform e-commerce website functions such as placing purchase orders, online payments, banking, order and delivery tracking through the Internet.

### 4.4 Technology infrastructure

Introduction and deployment of new information infrastructure are crucial to

1. provide adequate hardware and equipment for individual employees to carry daily business activities, such as personal computers (PCs), laptops, personal digital assistants (PDAs), printers, and many other peripherals,
2. connect the company's information systems and applications through the local area networks (LANs) or the intranet,
3. integrate the company's information systems

with business parties information systems through the extranet or virtual private networks (VPNs),

4. supply the company with the ability of accessing the Internet through a high-speed bandwidth connection and securing sensitive business information through the use of backup and restore equipment,
5. allow the company to enforce disaster recovery plans or business continuity plans for any causes of disasters, and
6. perform a secure and interactive website functions and interact with back-end information systems.

#### 4.5 Executive management

Changes of business strategy in executive management are critical to

1. support IT maintenances in hardware, software, databases, and networks,
2. incorporate policies, procedures, and processes for IT,
3. confirm that the company has agreed in the integration of enterprise wide information systems,
4. implement decision support systems for the best business practice, and
5. ensure that the company has consented to amalgamate the information systems with other business parties.

#### 5. Framework for managing changes in e-transformation

The underlying premise of managing changes in e-transformation framework (Figure 3) is that the integration of the e-transformation roadmap, five categories of changes in e-transformation processes and together with the validation process through the 7S model [4]. Both e-transformation roadmap and change categories have been described earlier in this paper; it is the final stage of constructing the framework by mounting change factors into the 7S model.

The fundamental concept of the 7-S model is that “structure” is not the only element representing an organisation; there are other six elements that form a complete organisation. These seven elements can be classified into two groups – tangible and intangible. Firstly the tangible elements, these are feasible and easy to identify. They can be found in the enterprise’s strategic plan, mission statement, organisational chart, and other corporate documentations. These tangible elements are strategy, structure, and systems. On the other hand, the intangible elements are those hardly feasible. They are difficult to describe and continuously developing and changing as the organisation evolves. These intangible factors include skills, staff, style, and shared values.

Figure 4 and the following subsections illustrate and describe these elements (both tangible and intangible) in

general as well as the context of e-transformation. The intangible ones are greyed out.

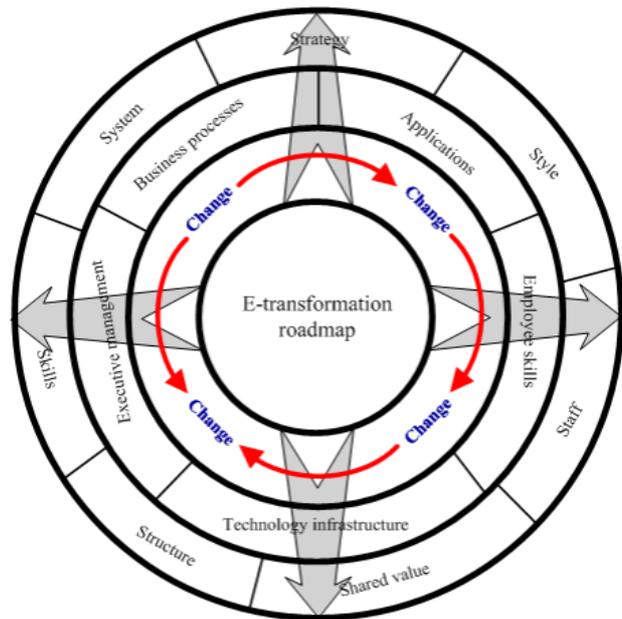


Figure 3. Framework for managing changes in transforming SMEs into E-capable companies

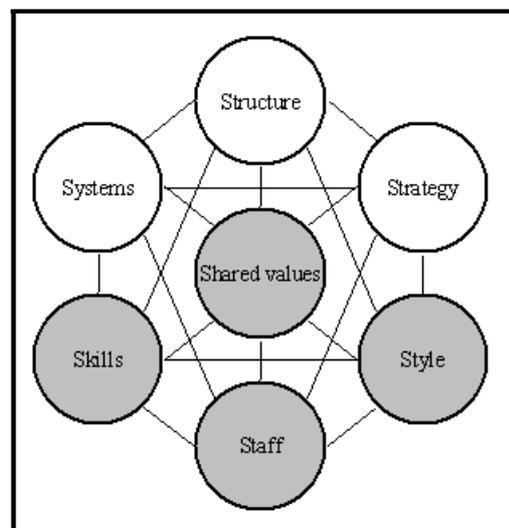


Figure 4. The 7S Model

#### 5.1 Tangible elements

##### 5.1.1 Structure

An appropriate managerial structure has to be established in order to successfully implement and support proposed changes. To achieve an effective enterprise with e-capable business functionalities, the establishment of communication channels between business functions and unambiguous definition of responsibilities for all levels of management require to be incorporated into the organisational structure. Companies need to ask themselves whether separate business functions are required to carry out e-commerce activities or incorporate the e-operations into the existing business functions. Further, the identification of people who are

responsible for any e-commerce activities, (eg. are they managers of each department?) Or whether new positions required for these e-management roles?

### 5.1.2 Strategy

It refers to actions an organisation plans in response to or anticipation of changes in its external environment. For example, the involvement of competitors in e-commerce operations may force the enterprise to shape its business plan to incorporate the e-transformation strategy.

### 5.1.3 Systems

It can be seen as formal and informal procedures and processes that support the strategy and structure. In the e-transformation context, systems comprise IT solutions and other techniques for collecting, processing, retrieving, and storing of information.

## 5.2 Intangible elements

### 5.2.1 Skills

The appropriate skills are required for implementing and maintaining e-capable business operations and an effective organisation. Such skills are mostly related to the application and utilisation of IT for advancing both the internal business operations and the external e-commerce development and implementation.

### 5.2.2 Staff

Referring to the human resource management. It includes processes used to develop managers, socialisation processes, methods of recruiting appropriate employees, and approaches of helping to manage and develop the careers of employees. As the introduction of e-commerce operations, additional staff are required to perform new emerging business and technical activities such as online customer and supplier management, administration of online transactions, maintenance of website contents, and any other IT supports.

### 5.2.3 Style

It can be seen as the culture of the organisation and management style. When implementing the fully e-commerce websites, enterprises will be facing an unprecedented challenge – sharing information with external business parties. In the e-commerce environment, inventory data, purchase orders, and sales information will intentionally be made translucent for the external business parties such as suppliers, vendors, and customers. Hence, changes of the organisational culture and management style are necessary to cope with the e-capable business operations.

### 5.2.4 Shared values

These are superordinate goals, guiding concepts, fundamental ideas around which a business is built. In the e-transformation context, the ultimate goals are to

construct and perform e-commerce operations through the amalgamation of the internal business systems.

By mapping the change factors of e-transformation with the 7S model, the following table (Table 1) intends to act as a diagnostic model for the completeness of changes required in the e-transformation processes. As the result of mapping, all change factors have been covered under the 7S model.

Table 1. Mapping of five change categories to the 7S model components

Change category	Change factor	7S model components
Business processes	individual employees working efficiently	style, staff
	connection of business functions	shared value, style
	information sharing between business parties	shared value, style
	keeping web contents up-to-date	strategy, style
	availability of dynamic web contents for external users	strategy, style
	Online transaction functions	strategy, style
Applications	integration of information systems amongst business parties	strategy, style
	industry specific software applications	system
	message transfer and email applications	system
	project management and scheduling applications, groupwares and intranet	system
	applications for implementing new emerging business processes	system
	applications for browsing static web contents	system
	applications for accessing interactive and dynamic web contents	system
applications for e-commerce functions	system	
Employee and skills	basic computer application skills	skills, staff
	communication and information sharing applications skills	skills, staff
	enterprise wide information systems skills	skills, staff
	Internet browsing and searching skills	skills, staff
	Internet interactive responding skills	skills, staff
Information infrastructure	e-commerce online transaction skills	skills, staff
	adequate hardware and equipment for individual employees	system
	intranet or local area networks (LANs)	structure, system
	extranet or virtual private networks (VPNs)	structure, system
	high-speed Internet connection and backup/restore equipment	structure, system
	facilities for implementing disaster recovery plans or business continuity plans	structure, system
Executive management	facilities for implementing a secure and interactive website functions and interact with back-end information systems	structure, system
	supporting IT maintenance	strategy
	incorporating IT policies, procedures, and processes	strategy
	agreement of the enterprise wide information systems integration	strategy
	consentience of information systems amalgamation with business parties	strategy

The proposed framework provides enterprises an overall picture of conducting the e-transformation

processes which begins with the understanding of all phases in the roadmap, recognising the changes occurred through five categories, and ensuring the entire enterprise has taken care of all change factors via the mapping of change categories to the 7S model components.

## 6. Development of a checklist for e-transformation achievement

Based on each company's current and progress status in relation to the e-transformation processes, a straightforward table-like checklist (Figure 5) is proposed to provide enterprises a quick and clear picture of the achievement in the e-transformation project. The checklist consists of the five change categories as the values of Y-axis and the first six phases of e-transformation roadmap (three externals and three internals) as the values of X-axis. Hence, it leads to the total of thirty cross-reference cells. Companies check each cross-reference cell when a change category has been accomplished for the corresponding e-transformation phase. For example, a tick should be given to the cell of employee skills and basic website when employees have the skills to access a basic website and functions. Once companies have checked all thirty cells, which means they have achieved both external and internal approaches in the e-transformation processes, and are suggested to move onto the convergence phase.

Change category	External phases			Ready for convergence process
	Basic website	Interactive website	E-commerce website	
Business processes				
Applications				
Employee skills				
Information infrastructure				
Executive management				
	Internal phases			
	Effective individual	Effective group	Effective enterprise	

Figure 5. Checklist for e-transformation achievement

## 7. Conclusion

During the process of e-transformation, companies usually face a variety of challenges. These challenges mainly associate with the changes occurred in various aspects in the organisation. Without realising and understanding the changes, the implication of e-transformation will not sustain and be part of the business strategy and operations. Hence, a framework for managing changes in an enterprise's e-transformation process is necessary. The framework development

embraces three main stages. Firstly, the e-transformation roadmap is reviewed through the investigation and identification of requirement and components of each transformation phase. The second stage deals with the classification of five e-transformation change categories. The third stage is concerned with verifying the e-transformation changes through the mapping of 7S model. Accordingly, the framework ensures changes occurred in the e-transformation process have been indicated explicitly and integrated into all aspects of the business operations.

## References

- [1] Ginige A., Murugesan, S. and Kazanis P. (2001). A Road Map for Successfully Transforming SMEs into E-Businesses. Cutter IT Journal, vol.14, no.5, pp.39-51.
- [2] Laudon K. C. and Laudon J. P. (2002). Management Information Systems: Managing The Digital Firm. 7th Ed. Prentice-Hall, Inc., Upper saddle River, NJ, p84.
- [3] Lan Y. (2002). GISM issues for successful management of the globalisation process. Proceedings of the Third Annual Global Information Technology Management (GITM) World Conference.
- [4] Waterman, R. Jr., Peters, T. and Phillips, J.R. (1980). Structure Is Not Organisation, business Horizons, vol 23, pp.14-26.

# A Supporting System for Knowledge Creation Process

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## Abstract

A knowledge management system, Knowledge Management System for Scientific Research Group (KMSSRG) is designed to facilitate knowledge creation within a scientific research group. Implementation issues of such a system are analyzed and discussed in this paper. The main feature of the KMSSRG is the support of Internal Knowledge Evolution Network (IKEN). We developed the IKEN by (1) using Ikujiro Nonaka's SECI model to identify core sub-processes and related knowledge that are keys to knowledge creation, and (2) analyzing carefully the knowledge creation process for both individuals and teams. As a result, IKEN is a directed network that maps knowledge (both implicit and explicit knowledge) fragments created by different team members in various research activities. Context reference relationships among these knowledge fragments can also be represented.

## 1. Introduction

Nowadays universities professor often does scientific research in groups with other professors and students. They need to share information between each other through the whole knowledge creating process. Although IT tools such as FTP, BBS, mailing list and Web site provide communicating of information, and the university library systems provide sharing of publications, the functions they provide are the same for groups as for any individual researches, with no outstanding effect on the efficient management of the valuable tacit knowledge that key to group knowledge creation. Both IBM Lotus and Microsoft released Knowledge Management Systems "maintaining a central knowledge database which keeps all the information of the team project including documents, contactor, mission, discussion"[1], but pieces of knowledge and their context reference are hidden inside the files "heaped" at the database waiting for "dug". In this paper we designed a system that can support Internal Knowledge Evolution Network (IKEN) which is a directed network that maps knowledge created by different team members in various research activities. With this system both implicit and explicit knowledge could be retained and the context reference relationship among the knowledge fragments could be easily traced.

## 2. Method

To design the support system we studied the formats of and the interaction between knowledge fragments in knowledge creation process. We started by subdividing the process into four stages according to the sequence of common researching: reference searching, reference reading and studying, topic researching, summarizing and paper drafting. Although each stage may go backward and intertwined with each other, we retain this subdivision for easy of discussion.

Then by applying Nonaka's concept of tacit/explicit knowledge and SECI model[2], we discussed what characteristic is of each stage knowledge and how tacit knowledge transforms into explicit knowledge, and how one's knowledge interact with the other's.

### 2.1 Nonaka's concept of tacit/explicit knowledge and SECI model

In Ikujiro Nonaka's study, the knowledge creation process is the conversion process between tacit knowledge and explicit knowledge [George Von Krogh, Ikujiro Nonaka, Toshihiro Nishiguchi'2000]. By his definition, explicit knowledge can be expressed in words and numbers and easily shared. Tacit knowledge, such as subjective insights or emotions, is non-articulated, and embedded in contexts and actions. It is personal and hard to verbalize or communicate. Tacit knowledge, such as bodily skills or mental models, is rooted in an individual's action and experience as well as in the ideals or values he or she embraces.

In the SECI model, the knowledge creation process within an organization takes a spiral evolution form, which consists of four types of conversions (figure 1). Socialization is the process of sharing the tacit knowledge of individuals. Externalization requires the articulation of tacit knowledge and its translation into forms that can be understood by others. Combination involves the conversion of explicit knowledge into more complex sets of explicit knowledge. Internalization means the conversion of newly created explicit knowledge into the tacit knowledge of individuals.

The model can better explained using the famous 'bread machine' case as follow:

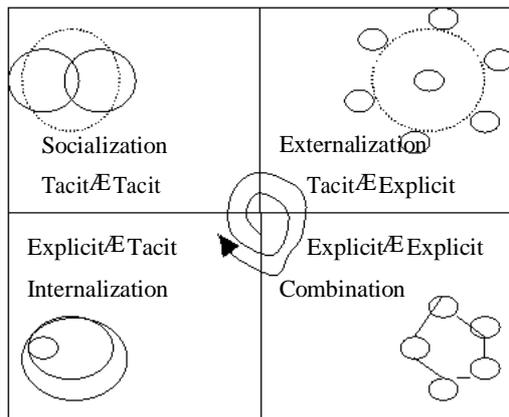


Figure 1. Nonaka's SECI Model

- ò Ms. T went to the famous bread baker to learn how to make the first-class bread by hand. The socialization conversion was implemented when the tacit knowledge of the baker was learned by Ms. T and remained tacit form in Ms. T.
- ò Ms. T shared her knowledge with her fellow workers by telling out the skill. The externalization conversion is implemented when the skill conveyed to the fellow workers in words.
- ò The group members worked together sorting out the knowledge and implemented the coding in the program of bread machine, the combination conversion is implemented when the knowledge is edited in systematic digital format.
- ò Then the machine along with its coding knowledge was accepted by other persons, the internalization conversion is implemented when the knowledge changed into tacit knowledge in the form of individual experience.

### 2.2 Basic processes for individual

To analyze the basic processes for individual, we list the content of both tacit and explicit knowledge (Figure 2), and discuss the transformation between tacit and explicit knowledge as that of SECI model.

Basic stages	Searching	Reading and Studying	Researching	Summarizing and Drafting
Explicit Knowledge	Publications such as papers, books	Comments on published works	Confirmation, Proof, Refutation	Papers, reports
Tacit Knowledge	Not remarkable	Problems, Suppositions	Advanced problems, suppositions	Not remarkable
Conversion		Explicit to Tacit	Tacit to Tacit	Tacit to Explicit

Figure 2. knowledge format and conversion

- ò In the searching process, the outside public knowledge resource are collected. The knowledge is in explicit form that stored in the published papers, books, or reports.
- ò In the studying process, both tacit and explicit knowledge are produced during the studying of outside resource. The explicit knowledge are comments or remarks on the published works, which are the externalization result of the personal internalization of published knowledge, a process of explicit to tacit to explicit. The tacit knowledge are embodied on guess and/or supposition to the solutions for project problems, which are subconscious imagination based on exist knowledge and personal experience. They are very obscure and not easy to be described concisely, and are often expressed with the aid of analogy or metaphor. They are of explicit/tacit to tacit process, and are the precursor of knowledge creation.
- ò In the researching process, both the tacit and explicit knowledge in studying process are further improved, with tacit knowledge develop into explicit knowledge, and with new tacit knowledge spring from existing explicit or/and tacit knowledge. For the tacit to explicit, the guess or supposition that can be testified are briefly proved in draft, which consist of set of knowledge fragments that will be systemized into new knowledge. For the explicit/tacit to tacit, new guess and/or supposition are continuously brought up based upon existing knowledge and personal experience.
- ò In the summarizing process, the fragments of research results are edited into systemized explicit knowledge, which is of explicit to explicit process.

### 2.3 Basic processes for team

Communication and interaction characterize team work. The exchange of opinions brings change to both the tacit and explicit knowledge. By observing the content of exchange and the transformation of knowledge, we can identify the core processes that are key to team knowledge creation. See table 1.

Table 1. the content of exchange and the transformation of knowledge in a team work

Basic processes	Types of knowledge	Content of exchange	Transformation of knowledge
Searching	Explicit	Information on the resource	
	Tacit	None	
Studying	Explicit	Comments or remarks on published works, as well as on exist comments	Accumulate: by sharing the study
	Tacit	Guess or supposition to solution of project problems, as well as comments on them	Accumulate: by sharing the insidious methods Knowledge creation: by provide new idea based on individual experience.
Researching	Explicit	Confirmation or proof to guess or suppositions, as well as comments on them	Accumulate: by sharing the proofs Knowledge creation: by jointly work on the same problems step by step.
	Tacit	More guess or suppositions, and more comments on them.	Accumulate: by sharing the insidious methods Knowledge creation: by provide new idea based on individual experience.
Summarizing	Explicit	Information on proof-reading	
	Tacit	None	

- ò In the searching and summarizing processes, the exchange focus on explicit information, such as the location of certain paper, or the proof reading of written draft.
- ò In the studying process, for the explicit knowledge, the exchange of comments or remarks on published works can speed up the accumulation of existing knowledge for each member. For the tacit knowledge, the exchange of guess or supposition diversifies the possible solutions, and arrests more attention on individual problem, which provide solid foundation for the next stage of co-work on attacking the problem.
- ò In the researching process, for the explicit knowledge, the exchange of fragments knowledge created help members to keep up with the current progress of project, and the insidious methodologies inhibit in the proof help to improve personal experience. For the tacit knowledge, more than one effort focus on individual problem. With the supplement of many efforts the power is amplified and the knowledge creation is accelerated.

## 2.4 Core sub processes

From table 1, we can see that the knowledge creation take place on studying and researching processes. Therefore, the studying and researching are core sub processes for knowledge creation. The knowledge

production can successively evolve in concord if the members can share both the tacit and explicit knowledge step by step, as seen in figure 3.

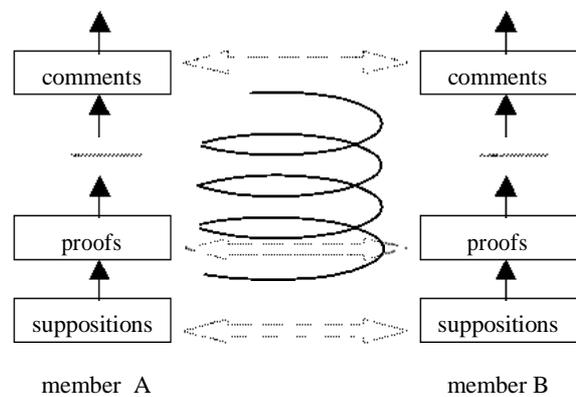


Figure 3 knowledge evolution in concord

## 3. Result

### 3.1 IKEN

And then we developed the concept Internal Knowledge Evolution Network to describe the knowledge evolution framework .

From the core processes identified in the above section, we can extract four types of knowledge.

- ò comments or remarks on published works
- ò guess or supposition to the solutions for project problems

- o proof or confirmation on the guess or supposition
- o positive or negative comments or remarks on knowledge 1-3.

These four types of knowledge increase in the process and are dependence on each other. When linking with their context relationships, the knowledge fragments created inside team construct a directed network map, as shown in the Figure 4. Along the direction of the arrows, pieces of tacit knowledge are continuously created based on previous knowledge, and converse to explicit knowledge. We define this network as 'Internal Knowledge Evolution Network'.

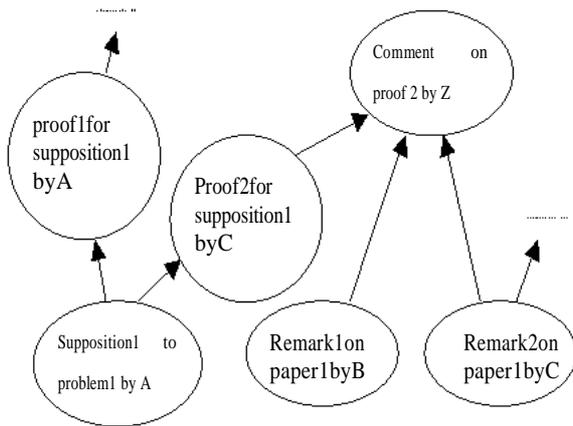


Figure4 InternalKnowledgeEvolutionNetwork

### 3.2 IKEN discussion

IKEN describes the inside team knowledge evolution map, with the similar idea as that of citation index service which provides knowledge linkage between published works. Knowledge linkages, both within and out of team, are important in creating new knowledge, but the IKEN is much important since it embody the tacit knowledge of each team member. The public knowledge is explicit and easy to locate without the risk of losing, but for tacit knowledge, it is the resource of creation which can not

afford losing. Therefore, managing IKEN is key to manage knowledge creation.

In addition, following is a list of more advantages on managing IKEN:

- o The progress of the research will not be stopped when someone leave. The personnel change used to be the most dangerous thing for project research. With the support of IKEN, the job can be easily taken over by other members, and new member can quickly keep up with the progress.
- o Virtual team can be better supported with digital IKEN which makes the members free of location.
- o Cooperation and communication obstacle caused by culture conflict or different habit can be overcome, since the digital IKEN provides more possible ways of exchange.

### 4. A Knowledge Management System for Scientific Research Group

From the previous analysis it's obvious that IKEN contains the tacit knowledge of the group. We devised a Knowledge Management System for Scientific Research Group – KMSSRG which can support IKEN..

In designing system we included other explicit knowledge resource such as books, papers, reports as the bottom layer of the knowledge (figure 5). One piece of knowledge may refers to multi-pieces of knowledge, and one piece of knowledge may be the reference of multiple pieces of knowledge.

### Acknowledgement

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### Reference

- [1]<http://www.Microsoft.com>
- [2]George Von Krogh , Ikujiro Nonaka , Toshihiro Nishiguchi, Knowledge Creation : A Source of Value, Palgrave, 2000

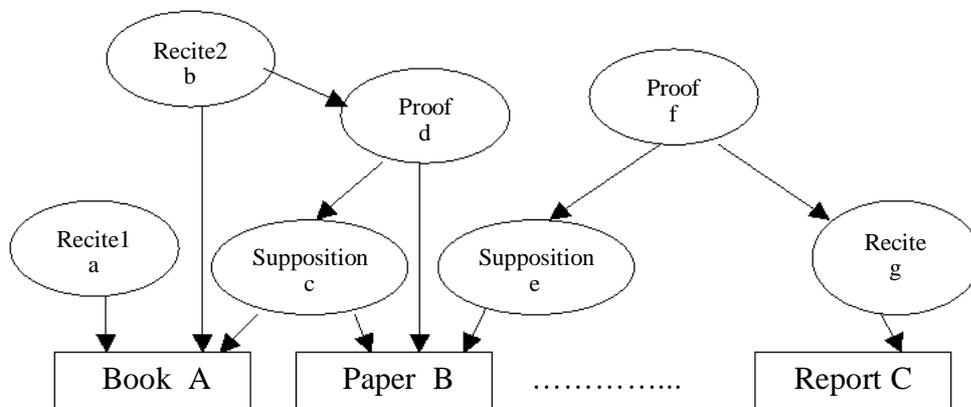


Figure 5 Extending IKEN by adding books, papers as bottom layer

# Towards a Framework for Discovering Project-Based Knowledge Maps

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## Abstract

Managing enterprise knowledge for decision support is crucial for enterprises to gain competitive advantages in knowledge-based economy. The valuable knowledge patterns hidden in numerous projects are important assets of enterprises. The management of such project knowledge is becoming increasingly important and challenging for organizational adaptation and survival in the face of continuous environmental change. This work proposes a project-based knowledge map framework to capture project knowledge and discover valuable knowledge patterns from previous projects. A collaborative two-phase data mining approach is applied to extract valuable project attributes, and discover their associations. Moreover, the discovered knowledge patterns are organized in a well-structured knowledge map, which facilitates effective navigation of project knowledge.

## 1. Introduction

Knowledge management is crucial to organizational adaptation and survival in the face of continuous environmental change [8]. The knowledge acquisition, storage and distribution activities in a knowledge management system enable the dynamic creation and maintenance of an enterprise's intelligence [7][8].

Knowledge management has successfully been applied in many business domains. Bolloju et al. [5] proposed an integrative model for building enterprise decision support environments using model marts and model warehouses as knowledge repositories. Massey et al. [10] proposed to reengineer the customer relationship by acquiring and disseminating knowledge to both customers and IBM's human experts. Moreover, metadata were used as a knowledge management tool for supporting user access to spatial data [13]. Rubenstein-Montano [11] surveyed knowledge-based information systems for urban planning and suggested the importance for moving towards knowledge management. The effectiveness of knowledge management has been demonstrated in these applications.

Recently, knowledge management has been considered in the field of project management. Tah et al. [12] applied knowledge management technology to identify project risk and to further improve project management. Barthès et al. [2] developed an agent-supported portal to organize knowledge in complex R&D projects. However, these applications overlook the valuable knowledge patterns and working experiences hidden in numerous projects.

Generally, a project is a 'temporary' endeavor

undertaken to create a particular product or service [14]. Unstable and temporary cooperation among a project team causes several difficulties in integrating knowledge, since the project team is usually disbanded and reorganized for another new project. This kind of volatile relationship hinders the accumulation of project knowledge. Moreover, a project can be carried out at different levels of the organization or across organizations. This complex scope results in difficulty in collecting integrated project knowledge.

Consequently, knowledge support is highly required throughout project development to solve these dilemmas. The numerous historical projects are the important knowledge source. The advance of data mining techniques has inspired applications in different problem-solving domains [4][6]. Applying data mining techniques to discover various hidden knowledge is a challenge for knowledge management [7]. Therefore, data mining approach is applied here to discover project knowledge.

This work proposes a project-based knowledge map framework to discover valuable knowledge patterns (project knowledge) hidden in projects, and to integrate these discovered patterns in a well-structured knowledge map. A collaborative two-phase data mining approach is applied to extract valuable project attributes, and discover their associations. The proposed knowledge map, clearly structured and semantically expressed, not only supports effective management of discovered knowledge patterns, but also assists users in navigating project knowledge to support further project development.

This paper is organized as follows. Section 2 describes a system model for discovering project-based knowledge maps. Section 3 illustrates meta information that pertains to a project. Section 4 discusses the mining approach to discover project knowledge. Section 5 elucidates the structure of the knowledge map. Conclusions and future work are finally made in Section 6.

## 2. System model

This section illustrates the system model for discovering project-based knowledge maps. As shown in Figure 1, three collaborative processes work together to construct the knowledge map, including extracting project meta information, mining project knowledge and finally deploying the project-based knowledge map.

First, the meta information builder is employed to extract meta information during project processing, including initialing, planning, executing, controlling and closing processes. Project meta information refers to the

important project attributes and annotations. When a project is finished to archive, the meta information is collected as well. The meta information builder appropriately annotates project attributes and converts these attributes to a consistent format for further analysis.

Second, a collaborative two-phase data mining approach is applied to extract valuable project attributes, and discover their associations. The first phase employs clustering methods to group projects into clusters according to their similarity. The second phase employs association rule mining to discover the inner knowledge patterns of the cluster of related projects, such as associations among project attributes. The discovered patterns reveal ontology-subject aspect and project domain concepts, which are very important in improving project development.

Third, the knowledge map builder integrates the discovered knowledge patterns and constructs a knowledge map to provide an information portal for accessing project knowledge.

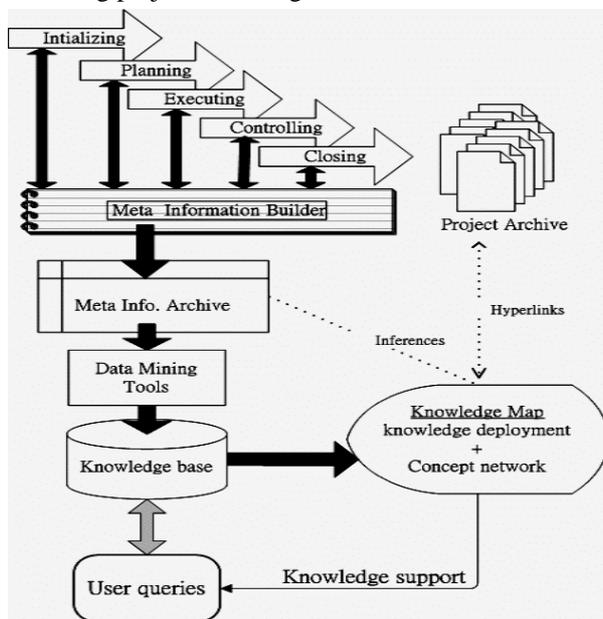


Figure 1. The system model of discovering project-based knowledge maps

### 3. Project meta information

A set of categories is used to classify project attributes. These categories may be pre-defined by human experts or generated ontology-based subjects for organizing project attributes consistently. This work considers five categories for software projects, Member, Tools, Activity, Goals and Cost, according to IEEE Standard for Software Project Management Plans (SPMP, IEEE Std. 1058-1998) [15].

- Member : a list of the key workers in a project.
- Tool : a list of major skills applied in a project.
- Activity : a list of key actions in a project.
- Goal : a list of objectives in a project.
- Cost : the financial cost and working weeks for a project.

Table 1 presents a set of example software projects. The set of project attributes, grouped by above defined

categories, constitutes the multiple project meta information. Accordingly, a vector model [3] is applied to represent these high-dimensional meta data.

Table 1. The collection of project meta information

	m1	m2	m3	m4	m5	t1	t2	t3	t4	...	g1	g2	g3	g4	g5	a1	a2	a3	...	c1	c2
P001	0	1	1	1	1	0	0	1	1	...	1	1	1	0	0	1	1	1	...	110	8
P002	0	0	1	1	1	0	1	1	1	...	1	1	1	1	1	1	1	1	...	40	6
P003	0	1	0	0	0	1	1	0	0	...	0	0	1	1	1	0	1	0	...	10	1
....																					
P100	0	1	0	1	1	0	0	0	1	...	1	1	0	0	0	1	1	0	...	60	7
P101	0	1	1	0	1	0	0	1	0	...	1	1	1	1	0	1	1	1	...	40	5
....																					
Pn	1	1	0	0	0	1	1	0	...	0	0	0	0	1	0	0	0	...	10	2	

Member : m1, m2, m3, m4, m5 denote Bob, David, John, Kim, Mary  
Tool : t1,t2,t3,t4,t5,t6 denote Parallel, Java, Data Mining , XML, DBMS, CGI  
Goal : g1,g2,g3,g4,g5 denote CRM, Logistics, Data Warehouse, Re-engineering, Wireless Communication  
Activity : a1,a2,a3,a4,a5 denote Marketing, Agency, Consultant, Alliance, Contest  
Cost : c1,c2, denote working weeks in total, total cost (Million dollars).

### Vector model

Each project is annotated as a set of key attributes, and a vector model is used to represent the attributes of a project. A vector is defined as follows. A weight value  $w_j \geq 0$  denotes the importance of project attribute  $j$  on project  $i$ . For simplicity, this work uses the values 1 and 0 for the weight value to indicate whether the attribute is important (presence) or not important (absence) to the project, respectively. A project  $P_j$  is associated an attribute vector  $P_j = (w_{j1}, w_{j2}, \dots, w_{jk})$ .

According to the meta information given in Table 1, project P001 is represented by a vector model (0,1,1,1,1,0,0,1,1,1,1,1,0,0,1,1,1,0,0,110,8), implying that project P001 includes the key team members David, John, Kim and Mary; employs the tools, Data Mining, XML, DBMS and Java; is aimed at CRM, Logistics, Data Warehouse, Re-engineering and Wireless networks; and involves the activities of Marketing, Agency, Council, Alliance and Contest. The final two items imply that this project cost 8 million dollars over 110 working weeks.

### 4. Mining project knowledge

The mining of project knowledge contains two phases. The first phase employs clustering methods to group projects into clusters according to their similarity. The second phase employs association rule mining to discover the inner knowledge patterns such as associations among project attributes.

#### 4.1 Clustering projects

This work employs an agglomerative algorithm that conducts hierarchical clustering to group projects in a

bottom-up way. The agglomerative algorithm places each object in its own cluster and gradually merges these atomic clusters into larger and larger clusters until all objects are in a single cluster [9]. The steps of the agglomerative algorithm include the following steps.

**Constructing a dissimilarity matrix:** The dissimilarity between projects depends on the distance between projects. This work uses Euclidean distance measurement to compute the proximity distance between *i*th and *k*th vectors. The pair-wise distance is useful to measure the dissimilarity and build a dissimilarity matrix for all attributes.

**Forming clusters:** The second step is to form clusters based on the dissimilarity matrix. A threshold value is an important parameter to decide how 'close' the projects will form a cluster. Projects with distance values less than a threshold value are grouped into the same cluster. For example, project P001, P100, P101 and P002 form a cluster labeled as 'Cluster#012', which is the main cluster example considered in the rest of this paper.

**Determining Cluster centroid:** A cluster of projects is a group of 'similar' projects, and a centroid is used to represent the key attributes of a cluster of projects. The centroid vector,  $C_j = (r_{j1}, r_{j2}, \dots, r_{jk})$  of a cluster *j* is determined according to the frequency (importance) of attributes. If the frequency (importance) of attribute *i* in cluster *j* is greater than a given threshold value, then  $r_{ji}$  is set to 1, otherwise it is set to zero.

The vector model is also used in the query module to find similar projects that match the partial concept or initial idea provided by users. The query includes multiple attributes from various categories, such as 'John, CRM', or a single attribute, such as ERP. Users could issue query using a partial concept or restricted conditions. A user query is represented as a vector model to indicate the query criteria of project attributes. The query result is determined according to the similarity between the query vector and the centroid vector. The similarity is quantified by the cosine of the angle between these two vectors. By ranking the similarity value, the system can find the most relevant cluster or find clusters with similarity greater than a given threshold value.

#### 4.2 Mining associations among project attributes

Association rule mining is employed to discover relationships among project attributes. This work applies Apriori algorithm [1] to discover associations among project attributes. Association rule mining extracts association rules that satisfy a user-specified minimum support and confidence. The support for an association rule,  $X \Rightarrow Y$ , is defined as the percentage of project instances in cluster *D* that contain both attribute sets *X* and *Y*, while the confidence is defined as the proportion of project instances that contain attribute set *X* that also contain attribute set *Y*.

The Apriori algorithm discovers large itemsets by means of multiple passes over the data. An itemset is a set

of project attributes. A large itemset is an itemset with support greater than minimum support. The algorithm is briefly illustrated as follows [1].

- In the first pass, Apriori counts the support of individual items and determine which of them have minimum support.
- Each subsequent pass starts with a seed set represented by the itemsets found to be large itemsets in the previous pass. From this set it generates the new potentially large itemsets, called candidate itemsets.
- At the end of the pass, it determines which of the candidate itemsets are actually large. This process continues until no large itemsets are found.

WEKA 3.0 software, an open source software issued under the GNU General Public License, is used for implementing Apriori algorithm [1]. Table 2 shows the mining result, and the support rules are explained as follows.

Table 2. The association rule of Cluster#012

WEKA 3.0.associations.Apriori	
Minimum support: 0.5	
Number of cycles performed: 189	
=== Run information === .....	
Best rules found:	
1. g3 ==> a3 .....	(1)
2. a3 ==> g3	
3. a1 ==> g1 .....	(2)
4. t5 g3 ==> a3 .....	(3)
5. t5 a3 ==> g3	
6. t3 a1 ==> g1 .....	(4)
7. t2 g3 ==> a3	
8. t2 a3 ==> g3 .....	(5)
9. m5 t3 ==> g1 .....	(6)
10. m5 g1 ==> t3	
11. m3 t2 ==> t5 .....	(7)
12. m3 t5 ==> t2	
13. t2 t5 ==> m3	
14. m2 ==> m5 .....	(8)

#### Support rules

##### Support#1: Team-member dispatch

A team of workers is the most commonly employed to complete a project. Based on rule (8) in Table 2, m2 and m5 are associated team members, as follows.

- David and Mary are suitable team members.

##### Support #2: Complementary relations

The relationship between cross-category attributes is useful to understand what kind of attribute complements each other. This kind of cross-category information is helpful to select suitable tools or appropriate activities to meet certain goals.

- (i) Data Warehouse and Consultant are two associated concepts according to rule (1) in Table 2.
  - The Consultant activity works for the goal of Data Warehouse.
- (ii) CRM and Marketing are two associated concepts derived from rule (2).
  - Achieving the goal of CRM requires the Marketing activity.

- (iii) Java, DBMS and Data Warehouse are associated concepts derived from rules (3) and (5).
  - Java and DBMS tools assist in the goal of Data Warehouse.
- (iv) Data Mining, CRM and Marketing are associated concepts according to rule (4) in Table 2.
  - The Data Mining tool and Marketing activity assist in the goal of CRM.

**Support#3: Members' skills**

Knowledge of members' skills is basic knowledge for supporting work assignments and determining what trainings needed. For example, rules (6) and (7) show members' skills.

- Mary has the skill of Data Mining.
- John has the skills of Java programming and DBMS.

Assigning team members, complementary relations among project attributes, and members' skills are very important tasks in managing projects. These support rules save much effort in initial planning of projects.

**5. Deploying project-based Knowledge map**

A knowledge map is developed to integrate the fragmental knowledge patterns discovered in the mining process. Such a map provides navigation facility to assist users in locating requested project knowledge.

The knowledge map developed here is a hierarchical structure that represents relationships among a cluster, categories, features, and objects. The cluster-node, at the first-level of the knowledge map, represents a cluster derived from the clustering analysis phase. The category-nodes, at the second level, denote pre-defined categories of project attributes. The feature nodes describe

the important attributes of a cluster. The object nodes denote project resources.

Moreover, the map shows a particular object instance, which is the finance sheet, including average cost estimates and time taken. This is a notable consideration for project development, since time and cost are two important factors that require knowledge support.

A clear project-based knowledge map is shown in Figure 2 to illustrate the integrated knowledge patterns of the Cluster#012. This unique map provides the following supports for knowledge seekers.

- (i) Domain concept: employed to provide a basic overview of relevant projects.
- (ii) Information portal: used to access detailed project resources for reference.
- (iii) Budget control: used to estimate the time taken and financial cost of a new project.
- (iv) Efficient query: a clear summary of a group of related projects in response to a query.

**Conceptual network for support rules**

The support rules discovered from the association rule mining are integrated in a conceptual network as shown in Figure 3. A conceptual network contains two types of primitive element, nodes and links. Nodes are used to represent project features (attributes), while links with labels are used to describe the associations between project features.

The generated concepts may imply important project knowledge, which accumulates working experience of senior experts. The clear structure promotes the reuse of the discovered knowledge, and the conceptual network helps users to understand project knowledge.

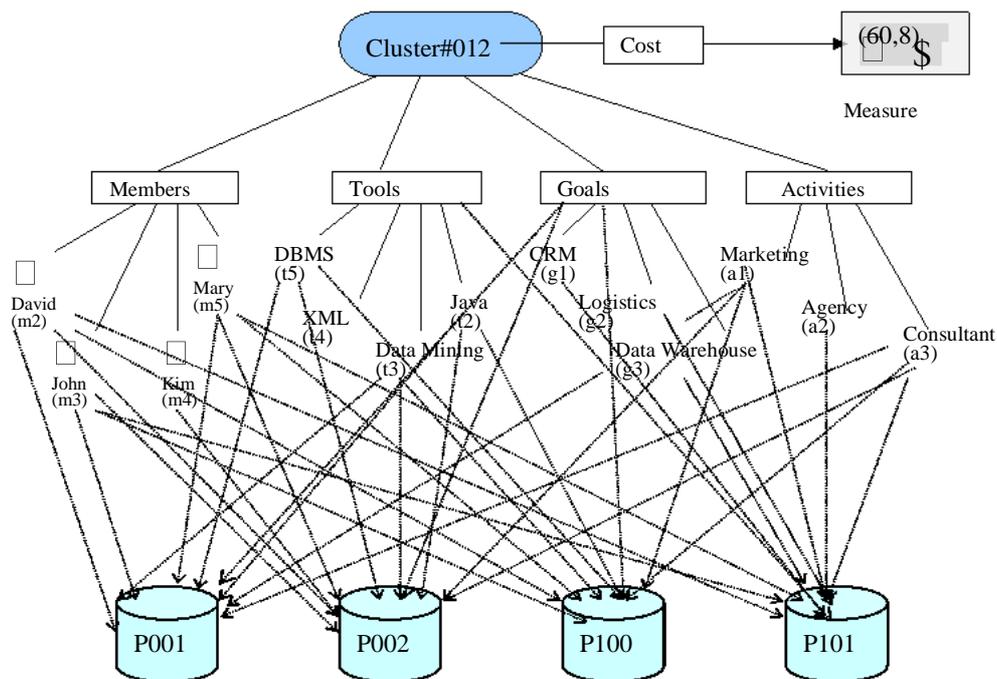


Figure 2. The knowledge map structure of Cluster#012

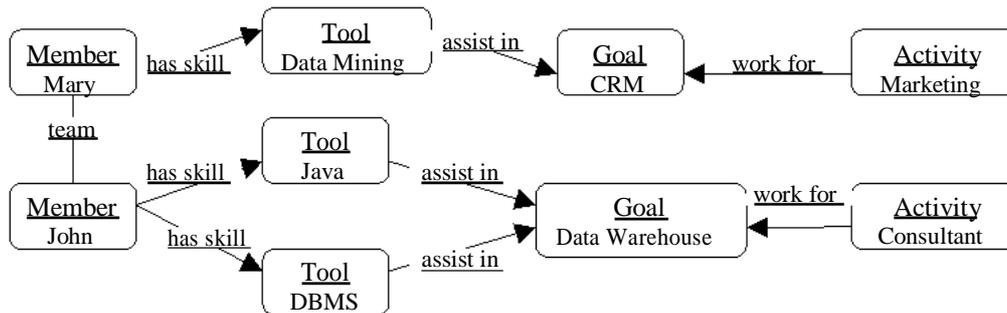


Figure 3. Conceptual network of Cluster#012

## 6. Conclusion and future work

The data mining approach is highly effective for extracting knowledge, but contributes less to knowledge sharing. The knowledge map, however, compensates for this lack. The proposed project-based knowledge map framework employs data mining approach to discover valuable project knowledge, and most importantly, integrates the discovered knowledge patterns in a knowledge map.

The approach provides effective knowledge support as follows. First, the knowledge map provides a simple but clear guide to clarify the distribution of project knowledge. Second, the extracted key attributes provide the project domain clearly. Third, each related project object is accessible by hyperlinks. Finally, the conceptual network captures important support rules discovered from the association rule mining.

The knowledge map is very helpful in supporting the management of project knowledge. Seeking innovative information technology to support other knowledge management tasks is an interesting future work. Moreover, the structure of the map must be further enhanced to increase the power of the knowledge representation. Finally, applying innovative data mining approaches in different phases to discover more valuable patterns remains a challenge.

## Acknowledgements

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## Reference

- [1] R. Agrawal, T. Imielinski, A. N. Swami, Mining association rules between sets of items in large databases, Proc. of the ACM SIGMOD Intl. Conf. on Management of Data, Washington, May 1993.
- [2] Jean-Paul A. Barthès, C. A. Tacla, Agent-supported portals and knowledge management in complex R&D projects, Computers in Industry, Vol: 48 (1), 2002, pp. 3-16
- [3] Ricardo Baeza-Yates, Berthier Ribeiro-Neto, Modern Information Retrieval, Addison-Wesley, 1999, pp15-25
- [4] M. Berry, G. Linoff. Data mining techniques: for marketing, sales, and customer support, Wiley Computer Pub., New York, 1997
- [5] N. Bolloju, M. Khalifa, E. Turban, Integrating knowledge management into enterprise environments for the next generation decision support, Decision Support Systems Vol: 33 (2), June, 2002, pp. 163-176
- [6] U.M. Fayyad, G. Piatetsky-Shapiro, P.Smyth, R. Uthurusamy, Advances in Knowledge Discovery and Data Mining, AAAI/MIT Press, 1996.
- [7] Gerhard Fischer, Jonathan Ostwald, Knowledge Management: problems, promises, realities, and challenges, IEEE Intelligent Systems, Vol: 16(1), January/February 2001. pp. 60-72
- [8] K. Harris, M. Fleming, R.Hunter, B. Rosser, A. Cushman, Gartner Group Report, The Knowledge Management Scenario : Trends and Directions for 1998-2003, Gartner Group Strategic Report 18, 1999
- [9] Anil K. Jain, Richard C. Dubes, Algorithms for clustering data, Prentice Hall 1988, pp55-69
- [10] Anne P. Massey, Mitzi M. Montoya-Weiss, Kent Holcom, Re-engineering the customer relationship: leveraging knowledge assets at IBM, Decision Support Systems Vol: 32 (2), December, 2001, pp. 155-170
- [11] B. Rubenstein-Montano, A survey of knowledge-based information systems for urban planning: moving towards knowledge management, Computers, Environment and Urban Systems, 24 (2000), pp155-172
- [12] J.H..M. Tah, V. Carr, Towards a framework for project risk knowledge management in the construction supply chain, Advances in Engineering Software, Vol: 32 (10-11), October - November, 2001, pp. 835-84
- [13] Lawrence A. West Jr. , Traci J. Hess, Metadata as a knowledge management tool: supporting intelligent agent and end user access to spatial data, Decision Support Systems, Vol: 32 (3), January 2002 pp247- 264
- [14] Project Management Institute, A guide to the Project Management Body of Knowledge, 2000 Edition.
- [15] IEEE Std. 1058-1998, IEEE Standard for Software Project Management Plans (SPMP)

# Knowledge Management for the Diffusion of Knowledge-Based Innovations

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## Abstract

This paper highlights the case study organisation of the National Science and Technology Development Agency (NSTDA) as a learning organisation. As NSTDA seeks to provide effective mechanisms for supporting small- and medium-sized enterprises (SMEs), it recognises the importance of knowledge as a mechanism for generating innovations. Thailand realises the importance of science and technology (S&T) for economic development, wealth creation and improvement in the quality of life. It is setting the direction and gaining commitment towards knowledge-based economy through the National Economic and Social Development Plans and phased programmes. In its effort to achieve this aim, the National Science and Technology Development Agency (NSTDA) plays a major role in propelling the national knowledge competence for social and economic development.

## 1. Learning organisation towards the knowledge-based economy

To support technical change at the national level and to transform technology (invention) into innovation (commercialised product), there needs to be an interaction between the public and private sector [1]. The National Economic and Social Development Plan Number 9 (2002-2006) sets out the direction that the public and private sector work together in order to support knowledge production, knowledge transmission and knowledge transfer within an economy. Learning organisation – the attempt of NSTDA to improve the

innovative capacity of the country can be shown in the Figure 1.

Currently, the manifestation of economy has been towards using information as a factor for competitiveness. For Thailand's progressing up the ladder of development, it has set up the NSTDA (a special kind of governmental organisation under the Ministry of Science, Technology and Environment) with the mission of supporting research, development, design and engineering (RDDE) in scientific and technological areas critical to the country's development. Underlying the NSTDA mission goal are three operational goals : the support of public sector RDDE projects; the support of the technological strengthening in the private sector; and the disbursement of science and technology scholarships for study abroad and locally. In effect, NSTDA's function comprises four main areas of responsibility :

### i) Research, development, design and engineering

The undertaking of RDDE includes the basic research, applied research to call for new scientific knowledge. The knowledge generation is to make effective application to the design of lab equipment and machinery.

### ii) Technology transfer

Technology transfer refers to the transfer of knowledge from innovation-oriented research projects to meet societal needs within the context of governmental policies.

### iii) Science and Technology (S&T) human resources development

The development of human capital is carried out by means of providing extensive education through schools, universities, vocational schools, distance learning approaches.

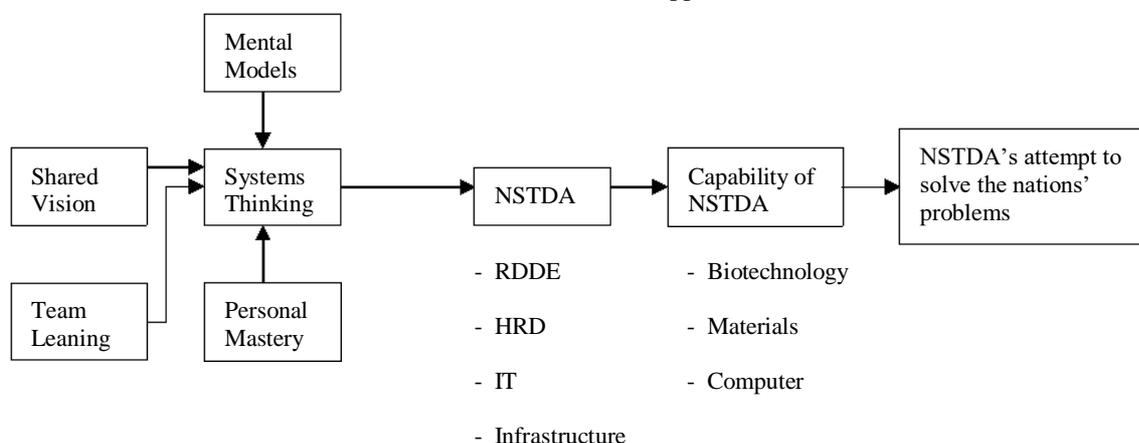


Figure 1 Learning organisation – the attempt of NSTDA to improve the innovative capacity

Table 1 R&D expenditures of Thailand

Year	R&D Expenditures (US\$ million)	R&D as % of GDP	Share of private sector
1989	113	0.17	5.5
1991	154	0.20	8.0
1997	210	0.18	15.0
1999	197	0.18	N/A

Source : The National Research council of Thailand, The National Science and Technology Development Agency

iv) Enhancement of S&T infrastructure

The principal services entail testing/QC services, certification, consultancy, training/ training co-ordination, intellectual property services to support research and development.

In the market-led economies, the private sector plays the crucial role in industrialisation. Research and development are recognised as a key factor to generate technical changes and improvements in industry. However, in Thailand, the private sector's spending in research and development is still negligible (Table 1)<sup>1</sup>. The problem is that although 80% of the firms in Thailand are SMEs, these firms generally do not engage in R&D activities. To put it another way, they tend to acquire technological capabilities from foreign sources at a superficial level – learning just to operate the systems.

Recognising the importance of private-sector technology development, NSTDA employs various policy measures. Among the policy measures to induce market-led economies are the followings.

1) R&D financing

As NSTDA's funding for R&D supports comes from fiscal budget, NSTDA becomes a major source of fund for providing supports to R&D activities in the public sector as well as private firms. At present, NSTDA has undergone the financial policies for SMEs by setting up NSTDA's Company Directed Technology Development (CD) program to provide financial support to enable private companies to invest in RDDE for commercialisation. The incentives to stimulate RDDE programmes in the form of financial assistance are grants and low-interest loans. Grants have a maximum limit of 75% of project expenses and do not exceed 3 million THB. The maximum amount given as a low-interest loan, which may cover up to a maximum of 50% of the total cost, is 20 million THB per project. The interest rate is one-half the interest rate for 1-year fixed deposits placed at banks plus 1.125% overhead charge. In granting loans, NSTDA considers that the research project of SMEs must accord to NSTDA's three priority areas, i.e. genetic

engineering and biotechnology, metal and materials technology; or electronics and computer technology.

2) R&D Tax Scheme

NSTDA undertakes the tax incentives to induce R&D investment in the private sector. In stimulating private-sector technology development, NSTDA offers tax incentives associated with setting up R&D laboratories and the related imports of machinery and equipment for use in R&D activities. The private businesses investing in R&D can deduct 200% of their R&D expenses for tax calculation<sup>2</sup>.

To encourage firm RDDE activities, other incentives include the increasing depreciation rate for laboratory equipment and machinery used in RDDE, the import duty exemption for the purchase of the equipment for RDDE, the tax exemption from sales of patents and inventions for a certain period of time.

To ensure the relevance of NSTDA's activities to the market demand of the industry, NSTDA also pursues 'demand pull' strategy by simulating the concept of 'clustering' [2] taken place at Silicon Valley in the US. In the US, public research, private (industrial) research and university research often have been intertwined closely [3]. The high technology incubators are set up to draw venture investment into the local economy. The mechanisms employed by NSTDA aim at coordinating and facilitating strategic collaborations and linkages between various research units, educational institutions and industrial sector. NSTDA is situated among the universities (Asian Institute of Technology, Sirindhorn International Institute of Technology, Thammasat University, Rangsit University, Bangkok University) which provide academic links to university research. It has established international collaboration link (e.g. Communications Research Laboratory in Japan, National Science Foundation in the USA, National Research Council in Canada) to ensure that the networks add benefit and value of generating more business for the firms. To the extent that government support policies influence a step further for private firms, NSTDA has orchestrated the R&D attack by getting firms to think through together which approaches ought to be followed and what directions pursued if commercial primacy were

<sup>1</sup> This percentage share contrasts with the situation in the advanced countries, where their private sectors accounted for 2-3% of GDP. The decreasing R&D expenditures in the year 1999 was an aftermath of the financial crisis.

<sup>2</sup> Science and Technology Development Program, Thailand Development Research Institute Foundation.

to be achieved. Clearly, the NSTDA Science Park offers resources to get the potential firms off the ground.

## 2. Conclusions

In this paper, the discussion has highlighted some interesting issues about the attempts of Thailand to develop technological capabilities and support SMEs towards the knowledge-based economy. Thailand will be able to survive in the rapidly changing economy provided the organisations and industrial sectors learn through R&D activities (not copy and development activities). This is because the method of learning, to some extent, determines the accumulation of technological capabilities. In effect, there needs to be collaboration between the public and private sectors in terms of developing the linkages and networks to push forward the governmental policy measures. This paper discusses the role of government, especially NSTDA, in producing effective mechanisms to support private enterprises. NSTDA's policy towards improving innovative capacity is in line with the National Economic and Social Development 9<sup>th</sup> plan in emphasising the development of R&D activities.

## References

- [1] APEC Economic Committee, Towards Knowledge-based Economies in APEC, APEC Secretariat, Singapore, 2000.
- [2] Porter, M., The Competitive Advantage of Nations, Macmillan, 1990.
- [3] Thackray, A. "University-industry connections and chemical research: an historical perspective", in University-Industry Research Relationships, National Science Board, Washington DC, 1982.

# Efficient Web-Based Planning Support for Training

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## Abstract

Collecting and analyzing training needs data using traditional survey method is extremely tedious and time consuming. Adopting a competence-based approach, this paper summarizes a conceptual model for effective training needs assessment, and presents an efficient web-based tool for assisting training specialists in conducting the needed analysis. Time saving benefit of the web-based tool was demonstrated. A sensitivity test was devised and found that the time saving benefit increases with employee size. A prototype system was implemented using MS IIS 5.0 web server, ASP web programming language and MS Access 2000 database. The complete process was demonstrated to a class of human resource managers and received favorable ratings on several measures of effectiveness and efficiencies.

## 1. Introduction

E-business is in. Company processes are being automated to increase efficiencies; business activities are linked by the newest web-technologies to add value to customers and users. In the midst of this e-frenzy, an important business process seems to be left behind. We found very few applications in support of the planning processes for the training and development of a company's most valued human capital.

The notion of a new knowledge economy reinforces the idea of employees being the most important asset. Human resource departments in many companies were compelled to look for ways to increase human capital [6]. From the perspective of long-term management, one viable way to increase a company's human capital is through carefully implemented HR practices such as training and development, performance evaluation and planned manpower changes [5]. Training, especially, is an important strategic practice in the development of internal competence.

Training activities preceded any knowledge management practices as the primary means to transfer organizational knowledge and "know-how's" to employees. However, unlike knowledge management practices, there seems to be a lack of efficient use of or coordination in modern technologies in training related processes. Though we have seen an increase in the utilization of a human resource management information system, from a humble 7% in the seventies, to 68% in the

eighties, and to a whopping 88% in the nineties, the applications are still limited to the more traditional aspects of personnel management, such as compensation and hiring [7]. Also, although e-learning is a sizzling topic for both the academia and the practitioners, the application deals primarily with the delivery of learning contents. The process of deciding who should get training on what, i.e., the planning process, is still done manually today. Blanchard and Thacker [1] highlighted the importance of structure and technology as the two internal factors which strongly affect an organization's competitive position. To improve an organization's competitive stand, we call attention to the use of the latest information technologies to support this strategic planning process called training needs analysis.

Swanson [9] proposed a technical training system model, including steps of analysis, design, development, implementation and evaluation. Needs analysis, the initial planning and analysis of a training program, is the most vigorous yet important stage in the training and development process. The accuracy of the analysis determines the legitimacy and effectiveness of training program design and subsequent deliveries in the latter stages of the training process. There are various ways to determine employees' training needs. The most commonly used method is survey questionnaires to the employees and their managers measuring the employees' skill level. However, as with any survey research, this method in its traditional manner is extremely tedious and time consuming.

This paper summarizes a conceptual model for effective training needs analysis, and presents an efficient web-based tool for assisting training specialists in conducting the needed analysis.

## 2. Competence-based Training Needs Assessment

Yeh [11] indicated that in the practical world, a training curriculum in a company is planned based on the following methods: 1) what available organizational resources are there, 2) by departmental functions, 3) what current management trends are, 4) in accordance with the labor law, 5) what corporate strategy calls for, and 6) how to fulfill corporate core competency. Since enhancing corporate core competencies has been a critical element for many companies to gain competitive advantage in their business [6], the competency-based training approach is

used to build the skeleton of the proposed conceptual model. As seen in Figure 1, the first stage of the model starts with identifying the company's vision, its mission statement, and business strategies, in order to flush out the company's core competencies. Deploying from the identified competencies, in Figure 2, a task analysis is conducted to further identify required knowledge, skills and abilities of a corresponding competency. Then needs assessment is conducted to measure the gaps of the required knowledge, skills and abilities between the "what-ought-to-be" in a company and the "what-is" in the employees. Finally, as shown in Figure 3, after ruling out non-trainable gaps, the training specialist plots the training curriculum for each employee by filling each individual gap with a learning activity.



Figure 1. Identify company core competencies

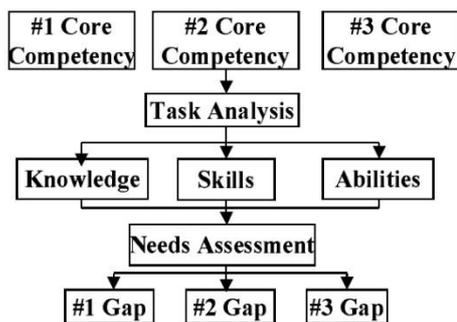


Figure 2. Perform task analysis and needs assessment

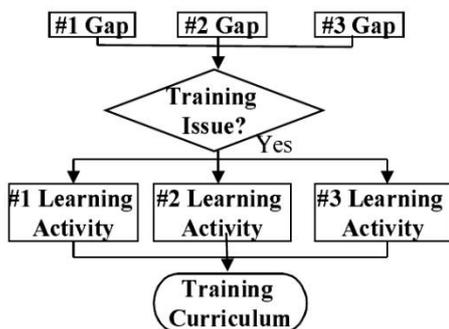


Figure 3. Design training curriculum

### 3. A Web-based Prototype System

This model provides an effective competency-based approach to planning a training program. This research converted the above conceptual model into an automated

process with necessary activities for the training specialist to accomplish the task of analyzing training needs. A supporting web-based environment is then constructed to assist the training specialist to design the training curriculum more efficiently. The functional structure chart as shown in Figure 4 illustrates the five sub-modules for training needs analysis, which includes 1) employee data management, 2) needs assessment management, 3) questionnaire design management, 4) training classes management, and 5) information. Employee data management includes basic data and training records sub-modules. Needs assessment management includes organization analysis, work analysis, and employee analysis sub-modules. Questionnaire design management includes questionnaire design, online questionnaire fill-out and questionnaire delivery sub-modules. Training classes management includes class data, scheduling data, and registration sub-modules, while information management includes BBS and message board sub-modules.

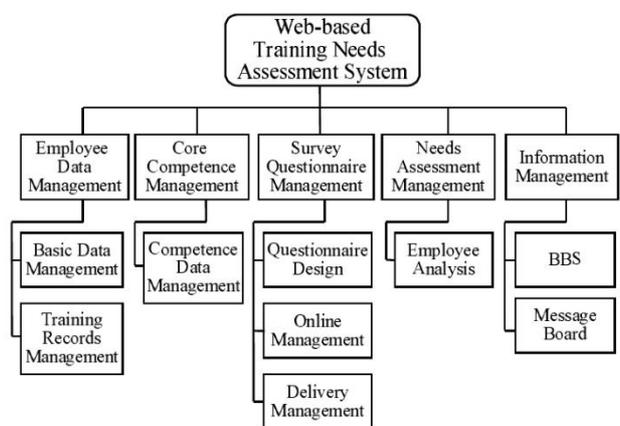


Figure 4. Functional structure chart

The web-based environment is designed to assist the training specialist to efficiently perform training needs analysis with the aid of intranet technology in the company. [10] The proposed prototype does not replace the role of a training expert. That is, the training specialist still needs to be skillful with the tasks of a training needs analysis, but the proposed web-based information system will make the execution of the process faster, easier and more automated.

### 4. Time Saving Benefit of the Prototype

Selander and Cross [8] proposed a two-stage process redesign analysis, which includes process mapping and value analysis, to evaluate the improvements and cost-savings of the new process. This research adopts the ideas of Selander and Cross by laying out the process of traditional training needs analysis, and identifying the tasks and errors which are not value added and can be deleted in the new process for cost-benefit justification. Accordingly, the claimed efficiency of our web-based prototype comes from the time saved for performing some of the tedious, time-consuming, and repeated tasks in training needs analysis processes, which include designing,

printing, and mailing the training needs questionnaires; collecting responding questionnaires, entering the data, calculating the survey results, and matching employee needs to training classes. These tasks have no value-added portions and can be converted to an automated process. The proposed system only requires the user to post the questions, setup the mailing list, schedule the survey, select the mode for calculation, and match intended training classes to needs questions; the computer will then do the

rest. Time saving increases with the employee size.

Table 1 compares the elapsed time by each process step of a traditional/manual training needs assessment with one that's done on the proposed prototype system. Time estimates for the prototype system are based on average operation, given basic employee data (e.g., name, department, e-mail address, etc.) are already entered in the system. For illustration purpose, we use very conservative, minimal time estimates for the manual process.

**Table 1: Assumptions of time spent on needs assessment process steps**

Process Steps- Manual Process		Process Steps- Prototype System	Elapsed Time - Manual	Elapsed Time - Prototype	Time Saving
Questionnaire design ( $\chi_1$ )		Questionnaire design ( $y_1$ )	3 hours	2 hours	$S_1$
Print survey ( $\chi_2$ )	In-house ( $\chi_{21}$ )	Send survey via e-mail ( $y_2$ )	1 minute	2 minutes	$S_2$
	Outsource ( $\chi_{22}$ )		24 hours		
Send survey ( $\chi_3$ )	On the spot ( $\chi_{31}$ )		1 minute		
	By mail ( $\chi_{32}$ )		24 hours		
Fill out survey ( $\chi_4$ )			24 hours	24 hours	$S_3$
Return the survey ( $\chi_5$ )	On the spot ( $\chi_{51}$ )	Fill out survey online ( $y_3$ )	1 minute		
	By mail ( $\chi_{52}$ )		24 hours		
Code the returned survey ( $\chi_6$ )		Execute data analysis to find competence gaps ( $y_4$ )	1 minute	1 minute	$S_4$
Enter survey data ( $\chi_7$ )			1 minute		
Conduct data analysis ( $\chi_8$ )	Using SPSS( $\chi_{81}$ )		1 minute		
	Using Excel( $\chi_{82}$ )		1 minute		
Calculate competence gaps ( $\chi_9$ )			1 minute		
Match competence gaps with employee training ( $\chi_{10}$ )		Match competence gaps with employee training ( $y_5$ )	1 minute	1 minute	$S_5$

Total time saving (TS) equals the sum of time saving in each process step ( $S_1, S_2, S_3, S_4, S_5$ ). Using the prototype system eliminates the editing and styling usually required when designing a survey questionnaire ( $S_1$ ). Sending the survey across the web eliminates the printing, publishing and traditional dissemination process altogether ( $S_2$ ). Similarly, other than the time required for the employee to fill out the survey, the system does not take any time to return the survey to the investigating party ( $S_3$ ). Traditionally, survey coding and data entry were the most tedious during a training needs assessment, not to mention the most error-prone. With automatic return, online database and built-in analytical tools, the system eliminates the coding and data entry steps altogether, and minimized the time and effort to calculate competency gaps ( $S_4$ ). Last but not the least, the system's automatic gap-to-training capability saves HR personnel a lot of time compared to a manual process to match training modules with each individual employee's competency gaps ( $S_5$ ).

Assuming a company of 120 employees was to conduct a competence-based training needs assessment, the total time saving (TS) realized by the company using the web-based prototype system would be: ("n" = number of employees = 120)

$$TS = S_1 + S_2 + S_3 + S_4 + S_5$$

$$= (\chi_1 - \gamma_1) + (n\chi_{21} + n\chi_{31} - \gamma_2) + (\chi_4 + n\chi_{51} - \gamma_3) +$$

$$(n\chi_6 + n\chi_7 + n\chi_{81} + n\chi_9 - \gamma_4) + (n\chi_{10} - \gamma_5)$$

$$= (180 - 120) + [(120 * 1) + (120 * 1) - 2] + [1440 + (120 * 1) - 1440] + [(120 * 1) + (120 * 1) + (120 * 1) + (120 * 1) - 1] + [(120 * 1) - 1]$$

$$= 60 + 238 + 120 + 479 + 119$$

$$= 1016 \text{ minutes} = 16.93 \text{ hours}$$

### Sensitivity test of employee size on time saving

To demonstrate that time saving increases with the employee size, a sensitivity test was conducted. Holding other variables constant, we quadrupled the number of employees twice and calculated the total time saving for both cases.

1). Time saving for a company with 480 employees:

$$TS = S_1 + S_2 + S_3 + S_4 + S_5 \text{ ("n" = number of employees = 480)}$$

$$= (\chi_1 - \gamma_1) + (n\chi_{21} + n\chi_{31} - \gamma_2) + (\chi_4 + n\chi_{51} - \gamma_3) + (n\chi_6 + n\chi_7 + n\chi_{81} + n\chi_9 - \gamma_4) + (n\chi_{10} - \gamma_5)$$

$$= (180 - 120) + [(480 * 1) + (480 * 1) - 2] + [1440 + (480 * 1) - 1440] + [(480 * 1) + (480 * 1) + (480 * 1) + (480 * 1) - 1] + [(480 * 1) - 1]$$

$$= 60 + 958 + 480 + 1919 + 479$$

$$= 3896 \text{ minutes} = 64.93 \text{ hours}$$

2). Time saving for a company with 1920 employees:

$$TS = S_1 + S_2 + S_3 + S_4 + S_5 \text{ ("n" = number of employees = 1920)}$$

$$\begin{aligned}
&= (X_1 - Y_1) + (nX_{21} + nX_{31} - Y_2) + (X_4 + nX_{51} - Y_3) + \\
&\quad (nX_6 + nX_7 + nX_{81} + nX_9 - Y_4) + (nX_{10} - Y_5) \\
&= (180 - 120) + [(1920 \times 1) + (1920 \times 1) - 2] + [1440 + \\
&\quad (1920 \times 1) - 1440] + [(1920 \times 1) + (1920 \times 1) + (1920 \times 1) + \\
&\quad (1920 \times 1) - 1] + [(1920 \times 1) - 1] \\
&= 60 + 3838 + 1920 + 7679 + 1919 \\
&= 15416 \text{ minutes} = 256.93 \text{ hours}
\end{aligned}$$

Results of the sensitivity test are tabulated in table 2. As shown, the time required when implementing a full-scale training needs assessment using the traditional/manual process multiplies quickly with increasing employee number. Whereas, the time takes to implement the same needs assessment using the web-based prototype system remains the same regardless of employee size. Consequently, the prototype system realizes tremendous time saving: 39.37% in companies with 120 employees, 71.35% in companies which employ 480, and 90.79% in companies of 1920 employees. Thus, we conclude that the time saving benefit is very sensitive to the number of employees subjected to the competence-based training needs assessment.

**Table 2: Effect of employee size on time saving**

No. of Employee	(1) Total Time-Manual	(2) Total Time-Prototype	(1)-(2) Total Time Saving	(1)-(2) / (1) % Percentage Time Saving
120	43	26.07	16.93	39.37%
480	91	26.07	64.93	71.35%
1920	283	26.07	256.93	90.79%

## 6. System Evaluation

The prototype system was implemented using MS IIS 5.0 web server, ASP web programming language and MS Access 2000 database. The prototype went through a two-phase evaluation process to establish its validity and effectiveness.

### Phase one—Quantitative measures

The purpose of the phase one evaluation was to gauge the validity of the competency-based needs assessment model and the prototype system from a practical standpoint. We looked for experienced HR practitioners as our study sample because they were most qualified to judge whether the system was valid to use in the field as a needs assessment tool. We carefully selected a class of students who were all registered in a MIS (Management of Information Systems) course offered through the HRM program in a major university. These students were studying for their master's degree in a graduate program designed specifically for experienced human resource managers and professionals. We conducted the evaluation toward the end of the MIS course to ensure that the study sample had adequate knowledge of the use of IS in human resource management. Thirty-one students participated in the study, most of whom had experience in training related jobs.

The complete process of a needs assessment using the prototype system was demonstrated in the MIS class. The demonstration took 40 minutes followed by a 20-minute Q&A. Then the class was asked to fill out a questionnaire. The questionnaire was composed of demographical questions and several measures of validity using a Likert-type scale of 1 to 5 (1 means strongly disagree and 5 means strongly agree). Descriptive statistical analysis and ANOVA were used to analyze the data.

The respondents' demographic characteristics are described below. The gender was balanced between males and females. While a majority (61%) had more than ten years of working experience, respondents were normally distributed on the six categories of the length of training-related experience. Although 68% reported working with a company that employed training and development personnel, only 50% of respondents believed that their company regularly conducts needs assessment. The profile of the respondents fit the purpose of our research nicely, and their responses on company's training function were within expectations.

Table 3 revealed the results of the validity measures. Respondents showed positive reactions toward each of the seven measures. The concept of a competency-based training needs assessment received most favorable ratings, followed by the use of gap analysis to assess these needs. Respondents were also impressed with the ability of the system to shorten operation time required of the planning process of a competency-based training.

**Table 3: Results of validity measures**

Validity Measures	Mean	S.D.
1. Agree with the concept of a competency-based training needs assessment	4.23	0.88
2. Agree with the concept of using gap analysis to assess training needs	3.84	0.90
3. The system effectively assist the planning of a competency-based training	3.32	0.94
4. The system simplifies the planning process of a competency-based training	3.48	0.93
5. The system shortens operation time required of the planning of a competency-based training	3.71	0.97
6. The system can effectively expedite the transmission of needs assessment information	3.65	0.91
7. The system makes analysis results of employees' competence gaps more accessible to training specialists	3.48	1.06

We also conducted an ANOVA analysis to find out whether the respondents' demographic background had any bearings on the validity of the prototype system. The results are presented in Table 4. Data showed, with three exceptions (marked by an \* in Table 4), differences among categories of each demographic variable were insignificant

on any of the validity measures. This served as a strong proof that the design of the prototype system was not biased toward any particular demographic group. With that

being said, a closer look at the three exceptions revealed somewhat interesting notions about the use of technology in the corporate.

**Table 4: ANOVA**

Validity Measures	Demographic Variables				
	Gender	Experience	Training related experience	Have training personnel	Conduct needs assessment
1. Agree with the concept of a competency-based training needs assessment	0.074	0.297	0.970	0.160	0.420
2. Agree with the concept of using gap analysis to assess training needs	0.155	0.156	0.878	0.018*	0.071
3. The system effectively assist the planning of a competency-based training	0.147	0.761	0.759	0.626	0.852
4. The system simplifies the planning process of a competency-based training	0.212	0.883	0.712	0.113	0.249
5. The system shortens operation time required of the planning of a competency-based training	0.086	0.257	0.283	0.042*	0.201
6. The system can effectively expedite the transmission of needs assessment information	0.023*	0.721	0.309	0.060	0.564
7. The system makes analysis results of employees' competence gaps more accessible to training specialists	0.152	0.569	0.826	0.312	0.506

\*  $\alpha=0.05$

As shown in Table5, males were stronger believers than females in the system's ability to expedite the transmission of needs assessment information. This finding seemed to reflect the stereotype of gender differences on technology, e.g., men are better at computers; men are more willing to embrace technology than women, etc.

**Table 5: Gender differences on validity of system**

Validity Measure	Mean	
	Males	Females
The system can effectively expedite the transmission of needs assessment information	4.00	3.27

Whether the company has training personnel influenced responses on two validity measures: 1) acceptance of the concept of gap analysis in training needs assessment, and 2) the system's time-saving feature in the planning of a competency-based training. (See Table 6) It's possible that companies with training and development personnel already have in place certain training needs assessment process or procedures, and believe that the gap analysis system is a better and more efficient alternative to their own practice. The disparity may also come from the fact that companies which don't employ training and development personnel don't usually conduct training needs assessment, therefore it is difficult for those respondents to grasp the ideas presented in the prototype system.

**Table 6: Whether company has training personnel on validity of system**

Validity Measure	Mean	
	Yes	No
Agree with the concept of using gap analysis to assess training needs	4.10	3.30
The system shortens operation time required of the planning of a competency-based training	3.95	3.20

**Phase two—Qualitative measures**

The purpose of the second-phase evaluation is to measure the effectiveness and the usability of the prototype system. To this end, we conducted one-on-one interviews with three training and development managers after they had experienced the operation of the prototype system hands-on.

The three T&D managers were from different industry background. Manager A was a T&D manager for a major department store and had 8 years of working experience in HR-related functions. Manager B worked as a T&D supervisor for a government agency for more than 10 years. Manager C was in charge of training for an area hospital and had 3 years of HR-related experience. Each manager received a 10-minute introduction of the competency-based training needs assessment model, then worked through each of the five modules of the prototype system to complete a hypothetical needs assessment process. The hands-on experience took 15 to 20 minutes, followed by a 30-minute semi-structured interview. Interview questions included the following: (See table 6 for a complete list of interview questions.)

1. Effectiveness, time-saving and accuracy of the questionnaire management module
2. Effectiveness and accuracy of the needs assessment module to calculate competence gaps
3. Whether the prototype system was easy to follow, straight-forward and user-friendly
4. Consistency of layout, appropriate size and amount of texts, appropriate use of graphics
5. Content accuracy, flow of information and legibility of the prototype system

Similar to the findings in the previous survey, all three managers agreed that the web-based prototype system provides a good model to assess employees' training needs, reinforces the concept of competency-based training, and simplifies the analysis stage of a planning process for training. While the training managers were positive about the effectiveness and the time saving prospects of the system, they also stressed the importance of customization to realize these benefits. The extent of customization included company organization and communication channel, a company-wise competency databank, training curriculum, process linkage to training

course registration and administration, etc. Concerns of employees mistaking a training needs analysis to performance evaluation were raised. Though not a system problem, one of the managers-Manager C-suggested adding this message to the survey: "For development purpose only, and will not be used in performance evaluation" to minimize the possibility of employees sending falsified information.

In terms of the functionality of the system, the managers suggested the following improvements:

- Provide multiple methods for data analysis or allow exporting of data to other statistical program for further data manipulation.
- Send an automatic confirmation when the survey is received by the intended employee.
- Provide better tracking mechanism, such as stats on send, reply and follow-up status.
- Provide better navigation functions, such as backtrack, system maps and on-line instructions.
- Provide options to setup the order of how respondents fill out the questions.
- Remind respondents of missing answers.

**Table 7: Interview questions and findings**

Interview Questions	Results	Improvement Suggestions
1. Do you agree with the concepts imbedded in the prototype system?	Positive	
2. Will the system facilitate the use of competence-based training needs assessment in your company?	Positive	- Customization is required prior to implementation.
3. Will the system help save time in planning employee training?	Positive	
4. Will the system simplify the planning process for employee training?	Positive	- Provide choices of analytical tools
5. Is the system effective in assisting the planning of a competency-based training?	Positive	
6. Effectiveness of questionnaire management module: Design? Dissemination? Collection?	Positive	- Automatic confirmation when message is received by the receiver. - Provide stats on send, reply and follow-up status.
7. Effectiveness of needs assessment module in quantifying employees' competence gaps?	Positive	- Stress "the survey is for developmental purpose only, and will not be used in performance evaluation"
8. Is the prototype system easy to follow and user-friendly?	Positive	- Provide system maps and on-line instructions.
9. Aesthetic appeals of the screen display: Consistency? Appropriate placement and size of text and graphic?	Positive	
10. Legibility, accuracy and flow of contents in the system?	Positive	- Provide option to setup the order of how respondents fill out the questions. - Remind respondents of missing answers.

## 7. Conclusion

We have presented a conceptual model in training needs assessment to assist organizations in their pursuit of competitive core competencies. We have also designed a web-based prototype system based on this conceptual

model to improve the efficiency and effectiveness in collecting and analyzing competence data for training and development purpose.

Neither the competence-based training approach or the needs assessment method is new to seasoned HR professionals. The method of using survey questionnaires

# An Empirical Investigation into the Impact of Electric Connectivity on the Adoption of Internet Banking

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## Abstract

In recent years, Internet banking has made dramatic progress across the world. In this paper, the nature and business rationale of Internet banking are briefly reviewed and analysed. Then a multiple regression model is proposed to study the relationship between electric connectivity (PC, Internet and Mobile) and customers' adoption of Internet banking. Empirical results are obtained and analysed. The results show that the electric connectivity has important impact on the adoption rate of Internet banking. Moreover the impact of each connectivity factor on the adoption rate of Internet banking is quantified.

## 1. Introduction

Banks such as Wells Fargo in the United States and Advance Bank in Australia launched their first Internet banking and bill pay services in 1995. Initially, investments in the Internet related principally to increasing distribution channels and providing information to consumers. Based on the success of these applications, coupled with the improvement in Internet security and consumer demand, many banks around the world have made major strides by offering full account access and transactions on the Internet.

Many banks have offered sophisticated functionality to their Internet banking customers. Customers can check their account balances and transaction history going back a few months, make transfers between accounts, pay bills online using bill pay services. They can also easily download account history into variety of formats for inclusion in many popular financial software packages. All these functionalities are backed by a high-level security.

There have been many studies on issues related to Internet banking. For example, KPMG [14] investigated the status of Internet banking in

Australia in the late 1990s. Studying the adoption of Internet banking in Australia, Sathye [22] reported that security concern and lack of awareness stand out as the reasons for no-adoption of Internet banking by Australian customers. Balachandher and Balachandran [2] provided an understanding of the factors that affect the adoption of Internet banking in Malaysia. Jun and Cai [13] attempted to identify key quality attributes of the Internet banking products and services by analysing Internet banking customers' comments on their banking experiences. Howcroft et al [12] explored consumers' existing financial services behaviour and assessed their attitudes towards home-based services, i.e., telephone and Internet banking. They found that branch network is still the most popular delivery channel in the acquisition of current accounts, credit-based and investment-based services. Moreover, consumer preferences reveal that they are not generally predisposed to change their behaviour radically and adopt widespread usage of telephone and Internet banking. Changes in the use of delivery channels will occur naturally as the population matures and computer usages "seep up" into the older age groups, but this process will undoubtedly take time.

However, there has been little empirical study on how the connectivity factors impact the consumers' adoption factors of Internet banking. This paper aims to fill this gap and to shed some light on this issue by establishing a regression model on the relationship between electric connectivity and the adoption of Internet banking.

The paper is organised as follows. First, the nature of Internet banking and analyse its business rationale is addressed. Second, a regression model is proposed and conducted. Then, the empirical results are reported and analysed. Finally, the results are summarised and their implications are suggested.

## 2. The Nature of Internet Banking

Strictly speaking, Internet banking is not the same as banking via on-line services. Internet banking means that [see e.g. 7, p51]:

- Consumers do not have to purchase any additional software (the web browser is sufficient), store any data on their computers, back up any information or wait months for new versions and upgrades, because all transactions occur on a secure server over the Internet.
- Consumers can conduct banking anywhere as long as they have computers (not necessarily their own) and modems---whether it is at home, at the office or virtually anywhere in the world.
- Consumers can download their account information into their favourite programs, which means that they do not have to follow the dictates of the service provider.
- Internet banking allows banks to break out of the hegemony of software developers.

However, in recent years, Internet banking has become the dominant form of all electronic banking. Thus, in the context of this paper, "Internet banking" and "Online banking" are used interchangeably.

The world is becoming increasingly open as a result of the Internet and the World Wide Web (WWW). Internet banking has been gaining ground around the globe. For example, a recent survey by online financial services provider Egg indicating that British Internet users are becoming more likely to use financial services on-line [1]. This offers banking institutions a new frontier of opportunities and challenges further augmenting competition in the global banking market. However, the success of this new distribution channel for banking products and services depends on many factors. For example, Sullivan [24] claimed that in general banks have been neither helped nor harmed by their early commitment to the Internet as a delivery channel.

The opinion that traditional banks were "dinosaurs" that the Internet would drive to extinction is no longer widely held. A study comparing new Internet-only banks with a peer group of new branch banks by De Young [8] showed the Internet-only banks have been substantially less profitable. They generate lower business volumes and any savings generated by lower physical overheads appear to be offset by other types of non-interest expenditures, notably marketing to attract new customers. However, Internet-only banking could eventually prove to be a viable business model. De Young [8] found that

profitability improves more quickly over time for the Internet only start-ups and they may benefit more from gaining experience and be better placed to realise economies of scale than their peers.

Most researchers and practitioners believe that disintermediation is unlikely to occur and financial intermediation is still essential in the age of the Internet. Internet banking requires high initial set-up costs (both technological and marketing) with savings following later. But it appears that no major banks had achieved cost reductions through Internet banking [cf. 15].

According to the KPMG [14] survey, the rapid growth of Internet banking was due to a number of factors:

- Availability of service
- Evolving Internet technology and standards
- Customer acceptance
- Industry consolidation.

Internet banking has grown dramatically in the past decade. It is likely to continue to grow in the future [23, 6]. In a nutshell, surveys by the American Bankers Association and Grant Thornton, a leading accounting, tax and management consulting firm, say four out of five community banks in the US have websites in 2002 and nearly 20% of bankers believe the Internet will be their leading consumer banking channel by 2005 [19]. As in the past, technological developments will play an important role in the future growth of Internet banking. For example, the following developments trends are predicted:

- "Foundation" technologies such as the web, XML, OFX and IFX and upgraded middleware will improve data access and integration
- Hot applications areas will include internal data security and authentication of customers and employees and risk management across the enterprise. Customer analytics and wealth management tools will also proliferate.
- Banks will retool websites and remote channels to offer better customer service. As part of this, more intelligently designed self-service will be featured.
- Payments-oriented middleware will get more sophisticated permitting such as cash management services as real time, comprehensive positive pay. Electronically bill payment and presentment and online procurement will, after a slow start, take off.
- The banks that will win will re-engineer their tools, process, and management to permit lifecycle marketing, or programs based on detailed customer knowledge.

In sum, it appears that the Internet banking still has a great growth potential due to technology

development and the further acceptance of e-commerce by consumers. But Internet-only banks would not replace the traditional banking business completely. Instead, they would rather co-exist.

### 3. The Business Rational for Internet Banking

The Internet has emerged as a key competitive arena for the future of financial services.

The reason behind the rapid development of Internet banking lies primarily in the (potential) benefits it offers to business and customers. These benefits are reflected in the following aspects: increased revenue, reduced costs and improved customer satisfaction [cf. 13, 16].

#### 3.1 Increased revenue

On the revenue side, Internet banking does have the following impacts.

- More account sales.
- Increased customer retention, on the accepted principle of "get them now, have them forever".

- Wider market reach. The Internet does not restrict banks to areas where they have a physical presence.
- Entry into new market opportunities. The provision of Internet share trading positions banks to tap into the fast growing online market. According to widely publicised statistics, online trading accounted for 30% of all discount trades in the United States in 1997.

Online services are a must for banks that have to compete with a growing number of services from other financial institutions, investment concerns, and insurance companies.

#### 3.2 Decreased costs

Internet banking requires high initial set-up costs (both technological and marketing) with savings following later. Once marketing and set-up costs have been incurred, transaction costs (admittedly, excluding the cost of customer support) appear much lower for Internet banking, especially in high-wage economies as illustrated in Table 1.

**Table 1. Relative costs of banking transactions**

	United States	India
Physical branch	100	100
Postal	..	40
Telephone	50	18
ATM	27	18
PC dial –up	8	na
Internet	1	12
Sources: Sato et al [23]		

#### 3.3 Improved customer satisfaction

The cost reduction associated with Internet banking comes from several aspects as follows.

- Reduction in traditional branch network infrastructure.
- Reduction in customer service staff as customers service themselves.
- Reduction in cheque processing costs due to increases in electronic payments.
- Decreased mail and distribution costs as statements, disclosures and other current paper items are delivered online.
- Less data entry as customers complete forms such as loan applications, changes of address and the like online.

In sum, the more transactions that can be converted to electronic form, the more money will be saved. The cost of an electronic transaction is dramatically less when done online, and customers do most of the work themselves.

Internet banking services that are well executed do lead to satisfied customers. For example:

- Allowing customers not only to see their account data but also to analyse it and adds value that is not available from a paper statement.
- Setting up of recurring bill payments and account transfers on the Internet allows customers to save time.
- Giving customers access to transactions, account balances and information anywhere offers great convenience than waiting in line at branch during business hours.

Of course, the Internet cannot perform every function for customers. Customers will at times need or want to talk to an actual person, so that option needs to be available (although multimedia may eventually reduce still further the need for person to person contact). Defining which services

add the most value on the Internet remains possibly the greatest challenge.

In sum, Online banking has the potential to solidify and extend a bank's relationship with its customers because it brings banking services directly to a customer's home or office. The more services a customer accepts, the more likely that customer will stay loyal to the bank.

Finally, we point out that the above advantages do not come for free. Banks do incur great costs in implementing their Internet banking systems. However, such investments are mostly short term or one-off. In contrast, the benefits are always long lasting. Banks also face enormous challenges from on-line banking (for more details, see e.g. 4, 24).

#### 4. A Multiple Regression Model

The basic research question of this paper is: how important is each of the connectivity to the adoption of Internet banking? To solve this complex question, a multi-regression model need to be established under some assumptions.

The primary factor determining the level of demand for Internet banking services will the number of people connected to the Internet. Internet banking is a relative new service. Much has been written on the factors affecting adoption or usage of new products or services. The adoption or usage of any new products or services has been well studied in the literature. For example, various theoretical model of adoption can be found in Rogers' work [20]. Mantel [17] evaluates the factors associated with the usage of electronic bill payment based on a sample obtained from a large survey. Some of the major psychological and behaviour factors which affect the adoption of any new innovation such as Internet banking includes: consumer awareness, ease of use, security, accessibility, techno phobia or simply reluctance to change, preference for personalised services and cost of adopting the innovation. In this paper, we attempt to examine a number of factors that affect the adoption of Internet banking across different countries. Thus, we can categorise these factors into two groups: national factors that are different from country to country, such as the connectivity, cost of Internet banking, etc.; individual factors that are similar to all countries, such as the security, awareness, etc. We also assume that all countries use a similar technology for Internet banking.

Without any doubt, the electric connectivity is a very important factor impacting the adoption of Internet banking. The connectivity factor can be divided into three parts: PC connectivity, Internet connectivity and Mobile connectivity. PC connectivity can be measured as the percentage of

population owning PCs in a country. Internet connectivity can be measured as the number of Internet hosts for a given number of population. Finally, Mobile connectivity can be measured as a percentage of inhabitants with mobile phones.

Another important factor that explains the adoption difference across different countries is the cost factor. In Internet banking, two types of costs are involved. First, the normal costs associated with Internet access fees and connection charges and secondly the bank fees and charges. Rothwell and Gardiner [21] observed that there are two fundamental sets of factors affecting user needs, namely price factors and non-price factors. To this extent, several researchers [[9, 11, 18] have identified price as a major factor in brand switching. If the consumers are to use a new technology, it must be reasonably priced relative to alternatives. Otherwise the acceptance of the new technology may not be viable from the standpoint of the consumers.

Due to the lack of data on costs, however, we are unable to include the cost factor in our regression model. As a rough model, we are only concerned with how important are the aggregate connectivity and each component of electric connectivity. In other words, we assume the relative cost of Internet banking is similar across different countries.

Based on the above assumptions, we propose the following model:

$$IBC_i = C + \beta_1 PC_i + \beta_2 IC_i + \beta_3 MC_i + e_i \quad (1)$$

Where:

IBC = Internet banking customer as a percentage of bank customers;

C = constant;

PC = personal computer use, measured as population owning personal computers;

IC = Internet connectivity, measured as Internet hosts per 10,000 people;

MC = Mobile phone use, measured as the percentage of people who are mobile or cellular subscribers.

e = error term.

Note that the impacts of all factors that are common to all countries are reflected in the constant term C. To estimate the model, a number of issues need to be addressed. First, we may encounter the *multicollinearity problem*. For example, the independent variables, PC, IC, and MC might be highly correlated. According to our intuition, this might well be the case and Internet connectivity and Mobile connectivity may be a more appropriate ones to use. To avoid such a

problem, we may also need to consider the following simplified regressions:

$$IBC_i = C + \beta_2 IC_i + \beta_3 MC_i + e_i \quad (2)$$

Or

$$IBC_i = C + \beta_1 PC_i + \beta_3 MC_i + e_i \quad (3)$$

Another problem we may encounter might be the autocorrelation which is data specific. This will be addressed later in the empirical results.

#### 4.1 The Data

To estimate the above models, we need data for various countries, which is hard to obtain. Fortunately, a number of sources, including the data presented in Claessens et al. [5], can be used to compile such data as of the end of 1999. The relevant data for 27 countries are presented in Table 2.

**Table 2. Internet banking and connectivity data**

Country	% of banks' customers using on-line banking	Personal computer use (% of population owning PCs)	Internet connectivity (Internet hosts per 10,000 people)	% of inhabitants with mobile phones
Australia	4	47	417	34
Belgium	4	32	162	31
Denmark	6	41	72	49
Finland	20	36	1057	65
France	2	22	83	36
Germany	12	30	161	29
Italy	1	19	59	53
Japan	0	29	133	45
Netherlands	15	36	357	44
Norway	8	45	715	62
Portugal	2	9	50	47
Spain	2	12	67	3
Sweden	31	45	488	58
UK	6	31	241	46
US	6	52	1123	31
<b>Argentina</b>	3	5	18	12
Brazil	5	4	13	9
China	0	1	0	3
Czech Republic	1	11	72	19
HK	5	29	120	63
Hungary	6	7	83	16
India	11	0	0	0
Korea, Rep. of	13	18	40	50
Mexico	3	4	12	8
Poland	1	6	28	10
Singapore	5	44	208	42
Thailand	1	2	3	4

A few observations on the data are as follows. There is a significant variation in the Internet banking adoption figures. In some countries, industrial as well as developing, Internet banking remains in its infancy. Meanwhile, other countries have a high level of Internet banking adoption. In Sweden, nearly one third of customers use Internet banking. In some emerging markets such as Korea, India, Internet banking adoption is also at a high rate.

Around the world, consumers and countries are increasingly getting connected. Advanced countries like the United States lead in terms of the percentage of the population that owns a personal computer and has the Internet access. The density of Internet services is also the highest in the most advanced countries. Among these countries, Nordic countries stand out with high connectivity. This high connectivity is augmented by the popularity of mobile phones, which are used by almost two-

thirds of the people in Finland and Norway and three-fifths in Sweden. Connectivity generally decline with income, though there are exceptions. For example, Portugal has low computer ownership and Korea has high connectivity, including through mobile phones--yet the countries' per capita incomes are quite similar (Portugal \$11384 and Korea \$9878 in 1999).

In many countries, connectivity has been increasing sharply in recent years. Between 1995 and 1998 the percentage of people owning a personal computer in selected industrial countries rose almost 60 percent. In a sample of developing countries the rise was 150 percent, albeit from a lower base [5]. Increased connectivity is not limited to advanced emerging markets, but is also becoming important in some of the world's least developed countries. Africa Online, for example, is

growing Internet provider in Africa (outside of South Africa). Access to telecommunications is being aided by new technology, such as mobile phones with increasingly large bandwidths. Around the world, connectivity is also being further enhanced by rapid improvements in telecommunications regulation.

Hence it is of vital importance to understand how connectivity impacts Internet banking.

## 4.2 The empirical results

We first run the regression model (1). This is a natural starting point as we do not have prior knowledge such as multicollinearity regarding the data. The regression results are reported in Table 3.

**Table 3. Regression result for Model (1)**

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.898015	2.306937	0.822743	0.4191
PC	-0.027721	0.132247	-0.209618	0.8358
IC	0.008666	0.005725	1.513603	0.1437
MC	0.102130	0.084834	1.203886	0.2409
R-squared	0.290411	Mean dependent var		6.407407
Adjusted R-squared	0.197856	S.D. dependent var		6.962864
S.E. of regression	6.236115	Akaike info criterion		6.634545
Sum squared resid	894.4500	Schwarz criterion		6.826521
Log likelihood	-85.56636	Durbin-Watson stat		2.039168

A few observations are as follows.

- None of the coefficients is significant at 10% level (5% level for one tail, assuming the electric connectivity has a *positive* impact on the percentage of population adopting Internet banking).
- The Durbin-Watson statistic shows that no autocorrelation exists at 5% level (with  $k^*=4$ ,  $n=27$ ,  $d_L=1.084$ ,  $d_U=1.753$ )
- The  $R^2=29\%$ , which implies that all connectivity variables aggregately can explain a fair amount of Internet connectivity across different countries.
- The coefficient for the independent variable PC is negative! This is counter to our intuition.

The above evidences show clearly that the regression model (1) suffers from the Multicollinearity problem. Thus the coefficients are highly misleading [cf. 10].

Hence, we need to try regression Models (2) and (3). The results are shown in Tables 4 and 5.

**Table 4. Regression result for Model (2)**

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.772345	2.182852	0.811940	0.4248
IC	0.007948	0.004497	1.767529	0.0899
MC	0.091127	0.065302	1.395462	0.1757
R-squared	0.289055	Mean dependent var		6.407407
Adjusted R-squared	0.229810	S.D. dependent var		6.962864
S.E. of regression	6.110642	Akaike info criterion		6.562380
Sum squared resid	896.1588	Schwarz criterion		6.706362
Log likelihood	-85.59213	Durbin-Watson stat		2.029693

**Table 5. Regression result for Model (3)**

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.285922	2.331502	0.551542	0.5864
PC	0.091964	0.108817	0.845122	0.4064
MC	0.093830	0.086903	1.079708	0.2910
R-squared	0.219730	Mean dependent var		6.407407
Adjusted R-squared	0.154707	S.D. dependent var		6.962864
S.E. of regression	6.401643	Akaike info criterion		6.655426
Sum squared resid	983.5448	Schwarz criterion		6.799407
Log likelihood	-86.84825	Durbin-Watson stat		2.119692

We can immediately draw the following observations:

All estimated coefficients in both Model (2) and Model (3) have the right signs. This confirms that the Multicollinearity problem existed with Model (1).

Model (2) has a higher  $R^2$  comparing to Model (3).

Both Akaike Information criterion and Schwarz criterion confirm that Model (2) is the preferred model.

Model (2) has an  $R^2$  of 29% approximately the same as Model (1).

Our empirical results show that the most significant variable in explaining the Internet banking adoption is the Internet connectivity. This is consistent with our common sense. The electric connectivity can explain approximately 29% of the variations in the Internet customer proportion across different countries.

According to our estimate, an increase of 100 in Internet hosts per 10,000 people corresponds to about 0.8% increase in the Internet banking customer proportion; an 10% increase in the mobile phone subscribers yields about 0.9% increase in the Internet banking customer proportion.

Of course, our results are subject to the quality of the data used. The data are related to Internet banking are extremely hard to obtain, let alone to

have high precision. Thus our estimates can be treated only as a rough guide. As a first such estimate, we believe that the results presented are of high significance, both to the industry and to the policy makers.

## 5. Summary

In this paper, we have studied the adoption of Internet banking and electric connectivity. First, various issues related to Internet banking are reviewed and analysed. Then a model for the relationship between internet banking adoption and electric connectivity is set up and empirical results are obtained. It is shown that electric connectivity, particularly, Internet connectivity is important to the adoption of Internet banking. To our best knowledge, we are the first to quantify the relationship between Internet banking adoption and the electric connectivity. Our results may have important implications to the Internet banking industry as well as the policy making. For example, our result indicates that the Internet banking customer proportion will increase at various speed relative to the increase in Internet connectivity, Mobile phone connectivity etc. This may help banks to predict their base of Internet banking customers and thus allocate the appropriate marketing effort and resources towards Internet banking.

## References

1. Anonymous, (2002), Egg survey looks at the uptake of Internet Banking in Britain, *Telecomworldwire*, April 2.
2. Balachandher S. and Balachandran (2001), Internet banking patronage: an empirical investigation of Malaysia, *Journal of Internet Banking and Commerce*.
3. Balachandran and Balachandher Krishnam Guru (2000), E-banking developments in Malaysia: prospects and problems, *Journal of International Banking Law*, Vol. 15, No. 10, pp250-256.
4. Boss, S., McGranahan, D. and Mehta, A., (2000), Will the banks control on-line banking?, *The McKinsey Quarterly*, No. 3, 70-77.
5. Claessens, S., Glaessner, T. and Klingebiel, D., (2001), E-finance in emerging markets: is leapfrogging possible? World Bank Financial Sector Discussion Paper, no. 7, June.
6. Claessens S., Glaessner T. and Klingebiel D. (2000), Electronic finance: reshaping the financial landscape around the world, World Bank Financial Discussion paper No.4.
7. Cronin, M.J., (1998), *Banking and Finance on the Internet*, John Wiley & Sons.
- De Young R., (2001), The financial progress of pure-play Internet banks, BIS papers No.7, 80-86.
8. Guadagni, P.M. and Little, J.D.C., (1983), A logical model of brand choice calibrated on scanner data, *Marketing Science*, Vol. 2, Summer, 203-38.
9. Gujarati, D.N., (1995), *Basic Econometrics*, McGraw-Hill.
10. Gupta, S., (1988), Impact of sales promotions on when what and how much to buy, *Journal of Marketing Research*, Vol. 25, November, 342-55.
11. Howcroft, B., Hamilton, R. and Hower, P., (2002), Consumer attitude and the usage and adoption of home-based banking in the United Kingdom, *International Journal of Bank Marketing*, 20 (3), 111-121.
12. Jun, M. and Cai, S., (2001), The key determinants of Internet banking service quality: a content analysis, *International Journal of Bank Marketing*, 19 (7), 276-291.
13. KPMG, (1998), *Internet Home Banking Survey*.
14. Lin, L., Geng X. and Whinston A., A new perspective to finance and competition and challenges for financial institutions in the Internet era, BIS papers No.7, 13-25.
15. Mahadevan, B., (2000), Business models for Internet-based e-commerce: an anatomy, *California Management Review*, Vol 42, No. 4, 55-69.
16. Mantel, B., (2001), Why do customers pay bills electronically? An empirical analysis, *Economic Perspective*, Federal Reserve Bank of Chicago.
17. Mazursky, D., LaBarbera, P. and Aiello, A. (1987), When consumers switch brands, *Psychology and Marketing*, Vol. 4, 17-30.
18. Poquette, B., (2002), Consumers flip to the Internet channel for financial services, *Banknews*, April.
19. Rogers, E.M., (1983), *Diffusion of Innovations*, 3<sup>rd</sup> ed., The Free Press, New York
20. Rothwell, R. and Gardiner, P., 1984, *Design and competition in engineering*, Long Range Planning, Vol. 7, No. 3, pp78-91.
21. Sathye M. (1999), Adoption of Internet banking by Australian consumers: an empirical investigation, *International Journal of Bank Marketing*, Vol 17 No.7, pp324-334.
22. Sato, S. and Hawkins, J., 2001, Electronic finance: an overview of the issues, *BIS paper* No. 7.
23. Sullivan, R.J., (2000), How has the adoption of Internet banking affected performance and risk in banks? Federal Reserve Bank of Kansas City, Financial Industry Perspectives.

# Understanding Internet Banking Adoption and Continue-Use Behavior: A Hong Kong Perspective

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## Abstract

This study investigates adoption/continue-use behavior within the context of Hong Kong Internet Banking services. A research framework based on the extended Technology Acceptance Model (TAM2) and Social Cognitive Theory was developed to identify factors that would influence the adoption/continue-use of Internet Banking. Structural Equation Modeling (SEM) was employed to examine the entire pattern of inter-correlations among the eight proposed constructs, and to test related propositions empirically. The results reveal that both subjective norm and computer self-efficacy indirectly play significant roles in influencing the intention to adopt Internet Banking. Perceived ease of use has a significant indirect effect on intention to adopt/continue-use through perceived usefulness, while its direct effect on intention to adopt is not significant in this study.

## 1. Introduction

Following the approach taken by Karahanna, Straub, and Chervany [30], this study combines innovation attributes and attitude theories in a theoretical framework to examine potential and early adopters' reasons for adopting and continuing to use Internet Banking. This study also attempts to provide a better theoretical understanding of the antecedents of user acceptance and user resistance to adoption and continue-use of Internet Banking in Hong Kong. In addition, it extends TAM by adding perceived risk and computer self-efficacy as external variables for perceived usefulness and perceived ease of use.

## 2. Literature Review

This study lies at the intersection of two issues. The first is the technology adoption decision-making process. The second is the determinants of information technology acceptance and utilization among users.

### 2.1 Social Psychology

Information systems investigators have suggested intention models from social psychology as a potential theoretical foundation for research on the determinants of user behavior [42]. Fishbein and Ajzen's [22] Theory of Reasoned Action (TRA) is an especially widely validated intention model that has been proven successful in predicting and explaining behavior across a wide variety of domains.

#### 2.1.1 Theory of Reasoned Action

TRA is a widely studied model from social psychology, and is concerned with the determinants of consciously intended behaviors [3][22]. It is composed of attitudinal, social influence, and intention variables to predict behavior. TRA hypothesizes that an individual's Behavioral Intention (BI) to perform a behavior is jointly determined by the individual's Attitude Toward performing the Behavior (ATB) and Subjective Norm (SN), which is the overall perception of what relevant others think the individual should or should not do.

#### 2.1.2 Theory of Planned Behavior

Despite the predictability of TRA being strong across studies, it becomes problematic if the behavior under study is not under full volitional control. To deal with these problems, Ajzen [1][2] extended TRA by including another construct called perceived behavioral control, which predicts both behavioral intention and behavior. The extended model is called the Theory of Planned Behavior (TPB).

## 2.2 Information Technology Acceptance

### 2.2.1 Technology Acceptance Model

The Technology Acceptance Model (TAM), introduced by Davis [20], is an adaptation of TRA specifically tailored for modeling user acceptance of information systems. TAM identifies a small number of fundamental variables suggested by previous research dealing with the cognitive and affective determinants of computer acceptance, and uses TRA as a theoretical backdrop for modeling the theoretical relationships among these variables. TAM posits that two particular behavioral beliefs, Perceived Usefulness (PU) and Perceived Ease Of Use (PEOU) are of primary relevance for computer acceptance behavior.

### 2.2.2 Extended Technology Acceptance Model

Venkatesh and Davis [48] added a number of determinants of PU to TAM to develop and test an extended TAM (TAM2). It is a theoretical extension of TAM, which explains PU and usage intention in terms of social influence processes (Subjective Norm, Voluntariness, and Image) and cognitive instrumental processes (Job Relevance, Output Quality, Result Demonstrability and PEOU).

### 2.3 Risk Perception

Risk perception is also a critical factor affecting the rate of adoption. Frambach [23][24] contended that the level of Perceived Risk (PRISK) is negatively related to

the speed of adoption. Ostlund [38] introduced risk as an additional measurement in IT adoption. A common and widely recognized obstacle to electronic commerce adoption has been the lack of security and privacy over the Internet [10][16][40].

### 2.4 Social Cognitive Theory - Self-Efficacy

Social Cognitive Theory (SCT) [6][7][8][9], also called Social Learning Theory (SLT), is a widely accepted model of individual behavior. A key element in SCT is the concept of self-efficacy (SE), which refers to an individual's belief in his or her own capability to perform a specific task. Estimations of SE are formed through a gradual and dynamic weighting, integration, and evaluation of complex cognitive, linguistic, social, and/or enactive experiences.

## 3. Methodology

### 3.1 The Research Framework

The attitude literature, including social psychology and technology acceptance, provides the theoretical framework needed to define the linkages between beliefs about adopting and using Internet Banking, while TAM2 provides the underlying structure for the theoretical model of the study. The proposed conceptual model of Internet Banking adoption for this study is shown in Figure 1.

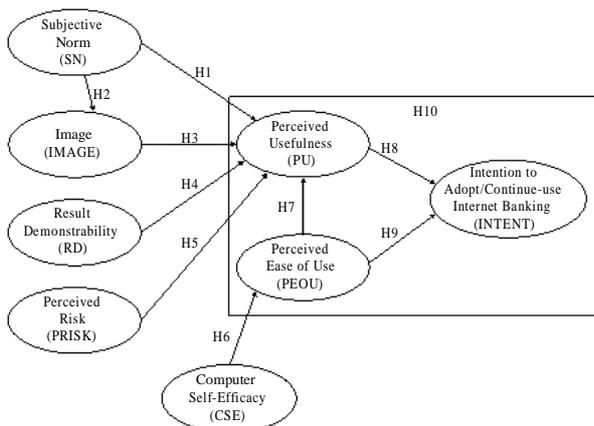


Figure 1 Proposed Internet Banking Adoption/Continue-use Model

The ten hypotheses required for the model test are shown in the first two columns of Table 1.

### 3.2 Questionnaire Design

Theoretical constructs were operationalized using validated items from prior research and the results of the elicitation study.

### 3.3 Respondents

The researcher limited the sampling frame to students under the age of 40 at the seven government-funded institutes of higher learning in Hong Kong. Eight hundred questionnaires were distributed with 634 responses (79.25% response rate). Of these, 183 were Internet Banking users and 451 were potential adopters of Internet Banking. After cases with missing data were eliminated,

the final sample consisted of 499 observations, of which 147 were users and 352 were potential adopters of Internet Banking. Males and females are approximately evenly distributed.

## 4. Data Analysis

The proposed research model was tested separately with the samples of users and potential adopters of Internet Banking via the structural path model. The partial aggregation approach was employed to reduce the level of random error. The results are as follows.

### 4.1 Users of Internet Banking

Analysis results indicate that INTENT was predicted by SN ( $\beta = 0.47, p < 0.01$ ) and PU ( $\beta = 0.53, p < 0.01$ ), which in turn was predicted by IMAGE ( $\beta = 0.11, p < 0.10$ ), RD ( $\beta = 0.40, p < 0.01$ ), and PEOU ( $\beta = 0.48, p < 0.01$ ). PEOU was predicted by CSE ( $\beta = 0.63, p < 0.01$ ). Image was predicted by both SN ( $\beta = 0.39, p < 0.01$ ) and RD ( $\beta = 0.40, p < 0.01$ ). The model explained substantial item variance: 34% of the variance in INTENT, 28% in PU, 60% in PEOU, and 52% in IMAGE.

### 4.2 Potential Adopters of Internet Banking

For potential adopters of Internet Banking, INTENT was predicted by IMAGE ( $\beta = 0.42, p < 0.01$ ), SN ( $\beta = 0.25, p < 0.01$ ), and PU ( $\beta = 0.15, p < 0.05$ ). PU was predicted by PEOU ( $\beta = 0.58, p < 0.01$ ), SN ( $\beta = 0.16, p < 0.01$ ), IMAGE ( $\beta = 0.10, p < 0.05$ ), and PR ( $\beta = -0.22, p < 0.01$ ). PEOU was predicted by CSE ( $\beta = 0.71, p < 0.01$ ). IMAGE was predicted by both SN ( $\beta = 0.19, p < 0.01$ ) and RD ( $\beta = 0.53, p < 0.01$ ). The above model also explained substantial item variance; 53% in INTENT, 34% in PU, 49% in PEOU, and 58% of variance in IMAGE.

Table 1 shows a summary of research results for both users and potential adopters of Internet Banking.

	Hypotheses	Users	Potential Adopters
H1	Subjective Norm will have a positive direct effect on Perceived Usefulness	Not Supported	Supported
H2	Subjective Norm will have a positive effect on Image	Supported	Supported
H3	Image will have a positive effect on Perceived Usefulness	Supported	Supported
H4	Result Demonstrability will have a positive effect on Perceived Usefulness	Supported	Not Supported
H5	Perceived Risk will have a negative effect on Perceived Usefulness	Not Supported	Supported
H6	Higher Computer Self-Efficacy will have a positive effect on Perceived Ease of Use	Supported	Supported
H7	Perceived Ease of Use will have a positive effect on Perceived Usefulness	Supported	Supported
H8	Perceived Usefulness will have a positive effect on Intention to Adopt/Continue-use	Supported	Supported
H9	Perceived Ease of Use will have a positive effect on Intention to Adopt/Continue-use	Not Supported	Not Supported
H10	Perceived Usefulness and Perceived Ease of Use will fully mediate the influence of selected variables on Intention to Adopt/Continue-use	Not Supported	Not Supported

Table 1 Summary of Research Results

## 5. Discussion

### 5.1 Intention to Adopt/Continue-use of Internet Banking

PU ( $\beta = 0.53$  for users and  $\beta = 0.15$  for potential adopters) is significantly positively related to INTENT, with 34% of variance of Intention to Continue-use and 53% of variance of Intention to Adopt, accounted for. This result is consistent with previous studies on TAM. It implies that if users/potential users perceive Internet Banking to be useful, they will be more likely to continue-use/adopt the innovation. Therefore, the result supports H8. The data also revealed that the effect of PU on intention was stronger for users than for potential users. On the other hand, PEOU is not significantly related to INTENT, contradicting expectations. Thus, H9 is not supported by the findings. This finding concurs with the original TAM but contradicts the results of many previous studies [33][37]. Furthermore, SN showed a significant positive relation to INTENT. This means that users feel more positive about using Internet Banking when the social environment encourages its use. This finding concurs with the extended Triandis Model by Cheung, Chang, and Lai [15], and the extension of TAM by Venkatesh and Davis [48]. However, the setting was different from studies by Venkatesh and Davis, in that the current context (Adopt/Continue-use of Internet Banking) is not mandatory. In addition, Image ( $\beta = 0.42$ ) was found to be the most significant factor affecting INTENT. Therefore, as the study has shown, IMAGE and SN were the main factors affecting INTENT for potential adopters.

### 5.2 Perceived Usefulness

Looking at the antecedents of PU, only IMAGE was significantly positively related to PU for both users and potential adopters of Internet Banking. The results support H3 that Image has a positive direct effect on Perceived Usefulness of Internet Banking. For potential users, SN and PRISK were respectively significantly positively and negatively related to PU, that is, both H1 and H5 are supported. However, H1 and H5 are not supported for users of Internet Banking. It could be argued that once users have adopted Internet Banking, their perceived usefulness is based mainly on their own personal evaluation of the technology, rather than SN. As for the different results of H5, PRISK ( $\beta = -0.22$ ) was significantly negatively related to PU for potential users. No significant relationship was found between PRISK and PU for users.

The finding of RD ( $\beta = 0.40$ ) implies that if Internet Banking produces effective/positive results desired by the users, they are more likely to understand how useful Internet Banking is. Therefore, H4 is supported for users. However, potential users may not be aware of these effective or positive results, or they may have no idea whether these results would be positive or negative. So, there is no support for H4 for potential users.

Furthermore, PEOU ( $\beta = 0.48$  for users and  $\beta = 0.58$  for potential adopters) was found to be the most significant

factor affecting PU, although it had no statistically significant influence on INTENT. The individuals' assessment of the usefulness of the innovation is influenced by the innovation's ease of use. All of which supports H7.

### 5.3 Perceived Ease of Use

CSE ( $\beta = 0.63$  for users and  $\beta = 0.71$  for potential adopters) was found to be a statistically significant factor of PEOU, and 49% and 60% of variance of PEOU was accounted for potential adopters and users respectively. The finding implies that individuals with higher CSE will perceive Internet Banking as easier to use. Therefore, H6 is supported. The data also reveal that the effect of CSE on PEOU was stronger for potential adopters than for users.

### 5.4 Image

H2 is supported. Both SN and RD were significantly positively related to IMAGE for both users and potential adopters of Internet Banking, and a large variance (52% for users and 58 % for potential adopters) in IMAGE was explained in the final model. The first part of the results conformed to prior studies of TAM2 [48], which theorize that SN positively influence image.

## 6. Conclusion

In this study, factors influencing the adoption/continue-use of Internet Banking are identified in the Hong Kong context. The results reveal that CSE plays an indirect, but significant role in influencing both intentions to adopt and continue-use of Internet Banking. Differences are found between the determinants of adopting and continuing to use Internet Banking. Risk perceptions of potential adopters hindered the adoption of Internet Banking. The majority of IS research in the belief/attitude tradition to date has focused on beliefs and attitudes related to usage of IT. Hence, our understanding of beliefs, attitudes, and norms leading to IT adoption and how these are modified over time is limited. Preliminary evidence from the current study suggests that perceptions of image enhancement induce initial adoption, while sustained usage decisions are based solely on beliefs of PU and SN. These results represent a first step toward a deeper understanding of the temporal evolution of beliefs, attitudes, norms, and behavior across different phases of the adoption process. Moreover, the degree of the mediating effect of PU is very high in continue-use intention, whereas it is not strong when explaining the adoption intention. PEOU is found to be an important antecedent of PU; however, its mediating effects on both adoption and continue-use intentions are not significant.

References will be provided upon request

# Financial Reporting for Electronic Resource and Service Expenditures: The Case of University Libraries in Taiwan

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## Abstract

Through a qualitative research procedure, this paper intends to explore useful accounting classification relating to electronic resource and service expenditures necessarily disclosed in a library annual report. As a result, based on line item structure emerged in this paper, an appropriate direction to develop library-specific Generally Accepted Accounting Principle for reporting electronic resource and service expenditures can be evolved in the future.

## 1. Introduction

Over the past five years, the number of electronic resources has substantially increased and that tendency becomes a paramount importance to library collection management. The negligible marginal costs of reproduction for electronic resources and the rapid development of information and communication technology have created new pricing strategies for information goods vendors through bundling, site licensing, subscriptions, rentals, differential pricing, per-use fees, and other various mechanisms. The complex pricing schemes have raised several issues to existing financial reporting: assets vs. expense, cost allocation of materials bundling, value reporting of electronics resources purchased via consortia, and accounting classifications. Among university libraries in Taiwan, accounting terminology and practices on electronic resources may vary widely from school to school. Ministry of Education (MOE) has conducted a survey for library materials budgeting for two decades. Nevertheless there still have such issues that both MOE and libraries need to find solutions.

In that sense this study addresses the following research questions: 1) how much expenditure that university libraries spend on electronic resources and services including electronic serials, monographs, audiovisual clips, bibliographic utilities and research database access respectively? 2) what is the current trend of using electronic resources and services in university libraries? 3) in terms of cost budgeting, how much expenditure is that for each individual library

spending on electronic resources and services while compared with other group member libraries? 4) after research database site license expired, in financial report, is it reasonable to claim on-line access fee as operating expenditure instead of capital expenditure and to classify those full text electronic journals (published during the term) as library assets and count them as serials holdings upon paying access fee for next year usage? 5) because of different pricing scheme for electronic resources and services, how do libraries count and allocate joint expenditures for the print-based and electronic-based subscriptions? 6) in order to seek for optimum cost-efficient purchasing solution, how do libraries disclose expenditure information and value holdings in the financial report under the structure of consortia? 7) in order not to under-value the holdings of e-version serials, how do libraries define and classify such serials for preparing financial statement?

Based on aforesaid research questions, from a financial and managerial perspective, this study intends to develop concepts of consistency and uniformity of financial reporting for electronic resource and service expenditures with a focus on simplicity, accuracy and flexibility as well as to construct a framework of accepted accounting principle for identifying accounting classification of electronic resource and service expenditures in university library. Thus this paper looks at the holistic view of electronic resource financial reporting model as opposed to the traditional approach of the library collection management.

In that proposition, a qualitative research procedure will be conducted. This study utilizes the in-depth interviews [6] to explore the phenomenon of financial reporting conflicts and discuss whether existing financial report is applicable to present electronic resource and service expenditures. In order to reflect realities of participants involved in the research environment, field notes analysis [14] and interview transcripts [16] will be also employed to guide the study and uncover critical issues from observations of interaction among participants whilst there have financial reporting conflicts within the library structure. As a result, through dialectic review with findings, this study will seek to

relevance and further contribute to its theory that constructs directions for new formats of financial statements for the desires of various audiences.

## 2. Starting with Essential Concepts

This paper expects to illustrate some concepts about some basic accounting terms, “what is financial report”, “who will need it”, “what is the relationship of financial reporting to library annual report” and “How does a library define its activities and materials involved”. Hence, this paper may apply such illustrations to library management and to have an effective communication both internally and externally.

### 2.1 Glossary of Some Basic Accounting Terms

In order to provide librarians’ concepts of basic accounting terms, some terminologies are described below.

**Accrual Basis Accounting.** In accrual accounting, income is recorded when it is earned rather than when the payment is received. With the use of that concept, expense is recorded when the item is purchased rather than the bill is paid.

**Balance Sheet.** It is a summary of an organization’s financial condition at a specific time point, including assets, liabilities and equity.

**Budget.** It is a process focusing on an itemized statement and forecast of an organization’s income and expenses expected for a period in the future.

**Capital Expenditures.** It is a category for long-term expenditures of depreciated items, such as equipment or furniture.

**Cash Basis Accounting.** In cash basis accounting, revenue is recorded when collected and expense is recorded when paid regardless of when the process was completed or the item purchased

**General Accepted Accounting Principles (GAAP).** GAAP are guidelines for preparing financial statements such as the balance sheet and the income statement external to the organizations. Such guidelines govern the recognition of revenue and the determination of whether a cost should be charged to expense or capitalized.

**Income Statement.** It is a report of sales, expenses and net profits for a given period of time.

**Operating Expenses.** It is a category for costs that are budgeted and expanded on an annual basis, such as salaries, subscriptions and continuations.

### 2.2 The Objectives of Financial Report and Its Users

Financial report is defined as a tool of financial reporting covering methods and accounting principles developed within a business framework. It is important to report to users inside or outside a business framework about the financial events of that business and in relation to communication of accounting information appropriate to users’ interests. As such, various types of users can determine the different objectives of a financial report. In the private sector, for example, either existing or potential equity investors need a financial report to whether invest in a business. The lenders, another example, need to ensure their exposure to a minimum risk through financial reports of the borrowers. In the public sector, an example is where the government needs a financial report for the purpose of taxation and economic decision-making. Specifically, the fundamental objective of a financial report is to communicate economic measurements of information about resources and performance of a business [1]. However, it is noted that different users, with different purposes, may require different information about the same items [9]. Thus, to have effective communication with users, such information further revealed in a financial report is often determined by the characteristics of usefulness underlined such as relevance, reliability, completeness, objectivity, timeliness and comparability [2].

Following the concept of effective communication, the effectiveness of a financial report is concerned with its users. In that sense, in addition to comply with the characteristics of usefulness, it requires a financial report different degree of complexity and depth for different users since not all the information required is likely to be included. An example is where based on users’ ability of understanding accounting information; a financial report must be geared to the knowledge of users.

### 2.3 Financial Reporting and Library Annual Report

In practice, there has no independent library-specific financial report but annual report for libraries services, particularly for library materials, in Taiwan. Conventionally, based on different report audiences, there have three objectives for an annual report. First, it shows MOE competitive information about the status of materials and services for funding. Second, it is used as a benchmark for MOE while evaluating University library performance. Third, it is a tool for University Board of Directors and University financial controller overseeing library administration and communicating with other library directors.

However, with the continuously strained financial situation of libraries and the advent of information technology that intensifies such budget restrictions, the information of an annual report needs to be extended to,

at either a internal or external level, provide them more accurate electronic information costs for effective communication and efficient decision making in a justifiable and comprehensive manner. Accordingly, from a financial accounting perspective, with the basic features of financial reporting in mind, whether an organizational context is profits-oriented or non profits-oriented, the standard format or principle (GAAP) of financial reporting can be applied to library annual report for the purpose of effective communication.

Given that purpose, as previously highlighted, various users determine types of accounting information disclosed in a financial report. Hence, in terms of non profits-oriented, considering the uniqueness of a library and objectives aforementioned, cost containment becomes very important if a library needs to remain viable. In that sense, activity-based cost accounting [15] is the most useful tool for analyzing the cost structures of a library [3] since library services can be illustrated by many activities, particularly for those focusing on electronic resources and services. Thus, with the use of such an accounting technique and following the concept of GAAP, information can be more accurate and comparable. In consequence, internally, cost performance and higher-level administrators like library directors, department heads and other supervisors can be fairly evaluated. Externally, an easy and better communication with relevant parties such as MOE and cross-campus library directors can be achieved.

#### 2.4 The Definition of Library Activities

Obviously, to determine types of information disclosed in an annual report by using financial reporting, activities like library services and materials associated need defined. In general, in terms of practical connected sequences of work processes, library services may include enquiry, interlibrary loan, information dissemination (circulation and acquisition) and document provision. Each of those activities may consist of many sub-activities. An example is where electronic documents delivery may consist of several processes such as the original document access, the document scanning, the delivery procedure initiation, account process and order delivery system administration. In that sense, to reflect library activities, an annual report shows the status of FTE (student and faculty), collection and circulation statistics with FTE, usage and reserve, loan transaction and inventory of collection.

Fundamentally, library materials associated with services are generally divided into books, periodicals, audiovisuals, CD, microforms, vertical file, etc. In particular, for those electronic resources, based on ARL (Association of Research Libraries) definition, they are deemed as electronic indexes and reference tools, electronic full-text periodical collections and electronic journal back-files and on-line searches of remote

databases where are whether assessed remotely or installed locally from CD-ROM, magnetic tapes and magnetic disks. In contrast to electronic resources, electronic services are deemed as materials purchased jointly with other institutions if such expenditure can be separated from other charges for joint services, bibliographic utilities if the portion paid for computer files and search services can be counted, and equipments that are inseparably bundled their costs into the price of the digital products.

Given that electronic resource and service being identified, expenditures can be deemed as costs spending on such products in bibliographic utilities, networks and consortia. However, such costs do not include expenditures for those not related to end-user database access and library system software only used by library staff. Specifically, expenditures can be divided into four major categories which are computer files, electronic serials and books, bibliographic utilities / networks / consortia, and computer hardware / software.

### 3. Background

The digital and network technology have provided an excellent channel for distribution and transaction of electronic resources. Over the past five years, the number and importance of electronic resources has increased. ARL Statistics 1999-2000 reveals that ARL university libraries reported spending almost \$100 million on electronic resources, an increase of \$23 million from the previous year. Currently most of university libraries have owned more titles of electronic serial than those of print-on-paper serial. How much are university libraries spending for electronic serials, monographs, audiovisual clips, and bibliographic utilities respectively? What are the trends of electronic resources in university libraries? How does an individual library's expenditure for electronic resources compare with other libraries? It sounds very simple, but in reality these questions are quite complicated. Such questions are to be expected as university libraries move into the digital era. However, acceptable and accurate answers still remain elusive. University libraries have suffered from the information disclosure on disbursement of electronic resources and services. That is because they had not found a reconcilable way and the general agreement of reporting those library materials.

Financial reporting shows the results of the budget and account operations. In that sense the above stated three questions are all integral parts of the one problem for financial management. The library materials and operating budgets are primary financial statements for university libraries, which are used by its intended audience to evaluate and ensure the best use of resources. The records in library materials and operating budgets maintained by the accounting procedure provide a

financial picture of historical collections and activities and are used to modify and clarify the budgetary plan for future collection development and operation. Holleman [10] argued that collection development was turning into collection management. University libraries have been positioning themselves with their library material budgets in regard to the access vs. ownership debate. The disbursement of electronic resource and service has become the one of major categories in the materials budget report. Of ARL member libraries, the average percentage of library materials budget devoted to electronic resources and services has increased from 3.6% in 1992-1993 to 13.5% in 1999-2000. Electronic resources and services are characterized by large fixed costs of production and near-zero marginal cost. The negligible marginal costs of reproduction for electronic resources make many types of bundling more attractive. Information goods were previously aggregated to save on transaction or distribution costs, but new aggregations of information goods will come out to extract more consumer surplus and create new profit opportunities. Because different libraries may have drastically different values and their willingness to pay for a particular electronic resource, values-based pricing and differential pricing schemes make more feasible and popular than cost-based pricing. As noted by Chuang and Sibru [5] and Ching, Shih and Chang-Chien [4], the Internet has created new pricing strategies for information goods vendors through bundling, site licensing, subscriptions, rentals, differential pricing, per-use fees, and various other mechanisms. Knight and Hillson [11] interviewed number of publishers, vendors, and agents and identified 16 pricing models. These complex pricing models in the electronic resources have raised several issues to existing financial reporting.

### 3.1 Asset or Expense

In Taiwan, many database vendors charge libraries fixed fee or unit pricing for the usage of electronic resources and services. Since the uncertainty associated with usage-related expenditures, conventionally, some libraries classify such costs as operating expenses instead of capital expenditures while recorded in the report. And upon the license expired or terminated, they would not continuously count operating expenses recorded electronic resources and services as library assets and / or holdings like volumes, serials and numbers of databases. Nevertheless, that accounting method is only acceptable to library materials, which are primarily tangible and obviously providing contributions to the library assets and holdings.

In contrast to tangibility, however recently some vendors, Wiley InterScience, for example, define their licensed electronic journals as online editions of their journals. In that sense, the Licensee has the access to such journals including retrospective and current electronic contents. After the license expired or

terminated, vendors would provide the License with access to the full text of the Licensed Electronic Journals published during the Term of this license by continuing online access to the same materials on vendors' server. In consequence, there raises several questions such as "is it still reasonable to claim such expenditures as operating expenses" and "can libraries report such electronic journals as library assets and / or serials holdings after the termination of the License?"

### 3.2 Cost allocation of materials bundling

Many electronic subscriptions such as SDOS, Academic IDEAL, and EBSCO Online include the print publication. Electronic resources may be main and joint products of publishing production process in the digital era, and the print publications may be byproduct. In that sense products can change from byproducts to joint products while their relative sales values increase sizably or change from joint products to byproducts as their relative sales values decrease sizably. There have three kinds of pricing schemes for electronic resources: print subscription plus add-on surcharge for the e-version, the electronic subscription plus add-on surcharge for the print or free (charged for the print only). In practice, the invoices issued by vendors don't need split off such two subscriptions. How do we count and allocate the joint cost for the print and the electronic subscriptions? In the case of free charge for electronic resources, would we only count and report the print subscription because that is what we purchased?

### 3.3 Value reporting of electronics resources purchased via consortia

As vendors have aggregated large collections of full-text journals, electronic resources are sometimes quite expensive, and easily drain out a large chunk of the library acquisition budget. As Poon [13] noted that by cooperating with other libraries, resources can be pooled together and shared, so that the "whole is greater than the sum of its parts". Under the limited budgets constraints, libraries consider that it would be in their best interest to form consortia to leverage their collective purchasing power. As a group, they have worked deals for huge databases and purchased them via consortia agreements. Would libraries count only the electronic titles for which they don't have the print subscription? In the case of consortia agreements, individual library could get access to all electronic subscriptions even if it doesn't have a print subscription for a specific title. How would member libraries of the consortia report the value of their holdings with the most cost-efficient purchasing solution?

### 3.4 Accounting classifications

As the information and communication technology enabled vendors to aggregate and disaggregate information goods, university libraries are not sure how to classify them properly and are struggling with the traditional uniform blanks for a variety of electronic

resources. In Taiwan, MOE conducts the library materials budget survey annually. To count electronic resources and services, MOE has constructed a new classification "Databases" which consists of two subset categories: "Bibliography" and "Full-text Journal". In an accounting context, this development is reflected in transformations of library materials such as intangibles, hybrid, and immaterial assets. To classify something also implies defining it. In fact, "intangibles" have no generally accepted meaning. Electronic full-text journal keeps the nature of serial. As university libraries shift the serial subscriptions from the print to the e-version, the holdings of serials in the financial statements will underreport due to classify them as database. When libraries employed a wide variety of funding and budgeting strategies to purchase electronic resources, it is very difficult for university libraries to find adequate definitions to classify data and disclosure financial information in a standard and comprehensive way. In the existing MOE's library materials budget survey, there is no accounting classification for monograph or serial received and not purchased.

With these issues illustrated, this paper actually focuses on how to alleviate such problems and report electronic resource and service expenditures by adding the framework of financial reporting within a library annual report.

## 4. Methodology

Ontologically, in qualitative paradigm, the realities of things be investigated are mentally constructed and multi-subjective [7]. Following the assumption of epistemology [8], this study will report these realities relying on languages (voices) and interpretations of informants involved. Furthermore, through continuous interactions, this study will seek different perspectives of informants [6] and will observe the realities by acting as an insider that has subjective, interpersonal and value-laden view [12]. Thus, methodologically, a qualitative approach that emphasizes authenticity, relevance and contextual applicability is used.

Six library director (three public and three private schools) and their financial controllers are selected to be the informants in this paper. Structured interview and fieldnotes analysis is conducted. In order to verify trustworthiness, peer review and cross checking with CPAs external to the university libraries are also utilized.

## 5. Discussion and Suggestions

Each of informants demonstrates an overall subjective response to issues, reflecting environmental and contextual factors that eventually determine the reality informants have. Accordingly, findings and discussion will be followed with suggestions.

### 5.1 Findings and Discussions

In examining issues mentioned about reporting electronic resource and service expenditures, the following findings are discussed.

#### 5.1.1 Lack of GAAP for Categorizing Library Electronic Resource and Service Expenditures.

The finding shows that there have two accounting principles for public and private schools respectively in Taiwan, when preparing annual reports for the various purpose of budgeting funding and performance evaluation. However, that leads to an inconsistency for reporting electronic materials among university libraries since categories are not unified and not generally accepted. In consequence, the lack of GAAP, which primarily emphasizes guiding university libraries when stating electronic materials either in quantity or dollar spent within their annual reports, is noted. Hence, through the finding, it is observed that the clear definition of electronic materials category is central to responding to set out its accounting classification following GAAP in the future.

#### 5.1.2 Unclear Category Basis for Accounting Classification.

Traditionally, categories often reflect materials by type (Seer 2000). An example is where this line item structure in which categories may include books, supplementation, periodicals, looseleaves and CD-ROMs, etc. The finding shows that existing electronic materials categories for two groups of public and private schools are not meaningful enough to reflect electronic resource and service expenditures since increasingly library materials become a hybrid nature as stated previously, such as the combination of books and CD-ROMs and the combination of print and Web publication. In addition to that, an argument of "intangibles" such as digital right and "consortia purchase" such as collective resource sharing is raised. Hence, again, it is noted that clear definition of electronic materials category is essential.

### 5.2 Suggestions

As a result of findings, in fact, to alleviate issues of reporting electronic resource and service expenditures in a library annual report, as a financial reporting way, in Taiwan, the baseline work will be focusing on constructing an appropriate line item structure for the purpose of accounting classification so as to establish GAAP appropriate to library services when preparing annual report.

#### 5.2.1 Reinforcing Line Item Structure.

Line item structure typically includes several broad categories, which are further divided into many sub-categories to fit the needs of the organizations. In reviewing existing two electronic material categories model required by MOE and Department of Higher

Education, in addition to the distinction in the definition of electronic materials categories, it obviously does not reflect the hybrid nature and the complex pricing of current electronic resource and service. In that sense, for example, for Department of Higher Education, the current line item structure of categories of CD-ROM, Web-based and Database for electronic materials is not broad enough and well established, not to mention MOE merely using Database to describe all electronic resource and service. Therefore, that leads to resources allocation distorted when making budget and / or evaluating performance.

Hence, this paper suggests that the line item structure for library materials should be more specific and divided into several layers in terms of material type, media type and source of such materials as shown in Table One (Appendix). From Table One, in general, the first layer is divided into two main categories of text and audiovisuals where include books / periodicals (serials) and CD / LCD / VCD / Web based respectively. Based on the first layer, the second layer will focus on the specific categories by type of media delivered, such as printed, CD-ROM, Web-based or microform, etc. When entering the third layer, library materials can be divided into different sub-categories based on the source of that material. For example, in each category from the second layer, it can be divided into subscription, exchange (loan) or collective shared from consortium.

### 5.2.2 Following GAAP.

To obtain the effectiveness of an annual report, upon accounting classification properly clarified, this paper suggests that an annual report matches GAAP for accounting practices, such as when reporting bundling (combination) expense, depreciation and intangibles. Normally, all categories and sub accounts tend to remain the same for the convenience of comparisons year to year. However, in order to reflect rapid changes in publishing industry and / or vendor ownership, in particular for electronic resource and service, adding new categories or eliminating existing ones are suggested to meet such changes. Nevertheless, it always bears in mind that no matter to what extent those changes may be; all categories adjustments must be in compliance with GAAP to ensure clear and comparable results.

### 5.2.3 Forming a Committee on Accounting Procedure .

Since the rapid changing nature of electronic resources no matter in format or delivery, another suggestion would be to erect an appropriate organization where can periodically review accounting practices and procedures so as to establish generally accepted practices for reporting library materials.

## 6. Concluding Remarks

In seeking to the effectiveness of a library annual

report showing electronic resource and service expenditure, an appropriate direction for accounting classification while preparing library annual report is paramount importance. In examining issues highlighted, it is noted that the baseline work to alleviate such issues would be relying on clarifying the accounting classification for electronic resource and service categories. In contrast to traditional category model, the new concept would focus on multi-layer structure wherein may have specific categories represented by type of materials, media for delivery and source of information. The structure also considers “intangibles” such as digital right incurred by the electronic resource transactions as well as the situation of complex pricing scheme under various combination of electronic resource purchased.

Based on that, it is concluded that an emerged framework of line item structure for library materials can be utilized as a guideline to set out a justified GAAP for non-for-profits organizations like library services. However, since the rapid changes of the information technology, a formal organization of committee on accounting procedure should be in place to accommodate accounting practices and support librarians' concern over the formulation and acceptance of Generally Accepted Accounting Principles. As a result, the effectiveness of a library annual report can be achieved to benefit library management where is in pursuit of continuous sufficient funding, high quality of service and better communication with all relevant parties internally and externally.

## References

- [1] Alexander & Nobes (3<sup>rd</sup> ed) 1994, A European Accounting Guide, Harcourt Brace, San Diego, CA
- [2] Alexander, D. & Britton, A. (5<sup>th</sup> ed) 1999, Financial Reporting, International Thompson Business Press, London.
- [3] Ceynowa, K. 2000, “Activity-based cost management in academic libraries- a project of the Germany Research Association”, Performance Measurement and Metrics, vol. 1, no. 2, August, pp. 99-114.
- [4] Ching, H. S., Shih, C. & Chang-Chien, J. J. 2001, ‘Economic Analysis of Scholarly Electronic Journal: Part 2’, Journal of Library and Information Science, vol. 27, no. 2, pp. 65-80.
- [5] Chuang, J. C. & Sirbu, M. A. ‘Network delivery of information goods: Optimal pricing of articles and subscriptions’, in Internet Publishing and Beyond: The Economics of Digital Information and Intellectual Property, eds B. Kahin & H. R. Varian, The MIT press, Massachusetts.
- [6] Creswell, J. W. 1994, Research Design: Qualitative and quantitative approaches, Sage, Thousand Oaks, California.
- [7] Creswell, J. W. 1998, Qualitative Inquiry and Research Design, Sage, Thousand Oaks, California.
- [8] Firestone, W. A. 1987, ‘Meaning in method: The

- rhetoric of quantitative and qualitative research',  
Educational Researcher, 16(7), pp. 16-21.
- [9] Hendriksen, E. S. (5<sup>th</sup> ed) 1992, Accounting Theory,  
Richard D. Irwin.
- [10] Holleman, C. 2000, 'Electronic Resources: Are Basic  
Criteria for the Selection of Materials Changing?',  
Library Trend, vol. 48, no. 4, pp. 694-711.
- [11] Knight, N. H. & Hillson, S. B. 1998, 'Electronic  
Pubs in the Web era', Information Today, vol. 15, no. 8,  
pp. 39-40.
- [12] Liang, X. Q. 2000, Managing in the Chinese Culture:  
Cross-cultural Interaction and Co-creation in  
Australian Invested Enterprises (AIEs), Research  
Proposal, Graduate School of Business, Curtin  
University of Technology, Perth.
- [13] Poon, P.W.T. 1994, 'Greater than the sum of its part:  
Building up a co-operative database of Pearl River  
Delta collection', Journal of Academic Library and  
Information, vol. 1, no. 3-4, pp. 161-167.
- [14] Silverman, D. 2000, Theory in Qualitative Research,  
Sage, London.
- [15] Smith, G. S. 1991, Managerial Accounting for  
Libraries and other Not-for-Profit Organizations,  
American Library Association,
- [16] Whiteley, A. 2002, Organisational Research  
Methodology 756, Lecture at Lingnan University,  
Hong Kong.

Appendix

Table One The Emerged Framework of Library Materials Categories for Accounting Classification

By Material		By Media	By Source	
Text	1.books	Paper-Based		Subscription
		Electronic	CD-ROM	
			Online	Exchange (Loan)
		Microform	Microfiche	Consortium
	Microfilm			
	2.serials{ including Periodicals, newspaper, annual report, conference proceeding, etc }	Same Above		Same Above
3.others(manuscriptEmap, atlasEpanphlet, etc)	Same Above		Same Above	
(Audio/Video Materials)	1.Audio	Tape		Same Above
		CD		
		LCD		
		Others		
	2.Video	Slide		Same Above
		Projections		
		Others		
	3.Others	FILM		Same Above
		VHS		
		VCD		
		DVD		
Others				

# Competitive Environment and Business Strategies for Online Brokerage Firms in Korea

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Note: The paper is based on the findings made by Koh, Lin, Nguyen, and Soegiarto during the Nanyang Business School (NBS) Business Study Mission (BSM) to Seoul, Korea, in June 2001. NBS is part of Nanyang Technological University in Singapore, and one of the leading business schools in the Asia-Pacific region. The four persons were MBA students at NBS at that time. The BSM dissertation they have written under the supervision of A/P Park incorporates their BSM findings.

## Abstract

Korea has recently experienced explosive growth in online stock trading, to the extent that the country is now one of the global leaders in this area. In this paper, we examine the implications of this phenomenon on the competitive environment facing retail brokerage firms in Korea as well as their potential strategic responses. Online trading entails low entry barriers and more demanding customers, and thus creates intense competitive pressures. Only those brokers that adapt their business models flexibly and quickly to the new environment, in particular by relying more on customized, fee-based services and less on trading commissions, will make the grade. Although our study is focused on Korea, most of its lessons, particularly those relating to strategic responses for brokers, are applicable to other markets as well.

## 1. Introduction

Figures 1 and 2 below summarize the growth of online stock trading in Korea, which has now become a global leader in this area. The speed and magnitude of the growth can be best described as extraordinary.

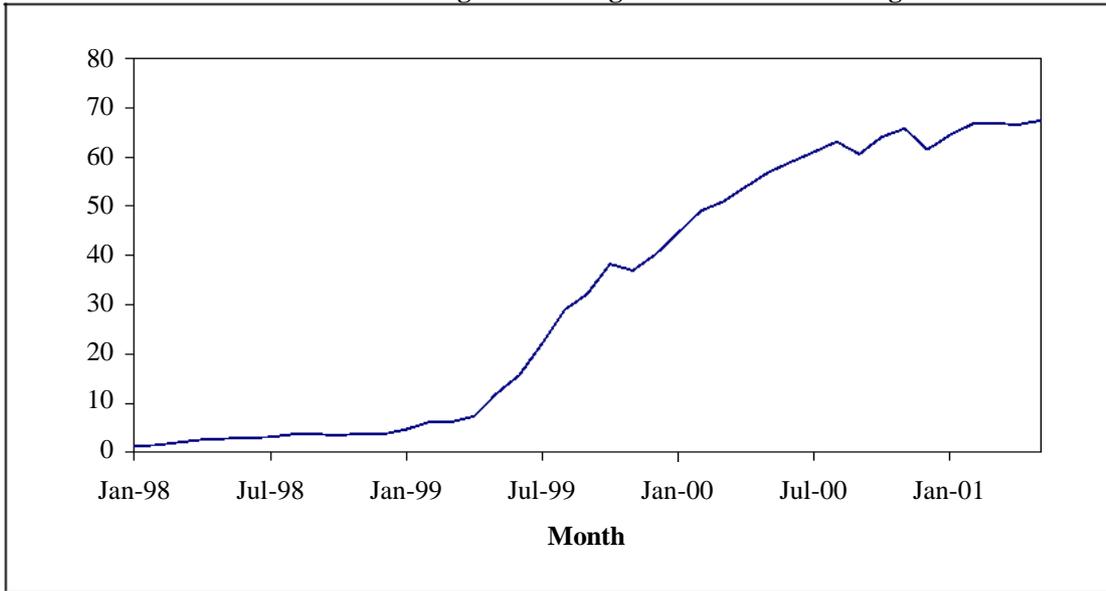
It was not until April 1997 that the Korean government amended the *Securities and Exchange Act* to allow trade orders by telephone, telegram, fax, computers or other electronic communications devices in addition to traditional document-based orders, thus making online securities trading possible. In January of 1998, only 1.3% of total trades were conducted electronically. By May 2001, the figure had soared to 67.4%, the highest in the world, with online trading

value surging 280-fold from 0.5 trillion won to 141 trillion won (Korean Industry Update, 2001).

As the interest of Koreans in online trading intensify, the number of online trading accounts continues to explode. In January 1998, there were only about 78,340 online securities accounts, but by May 2001, South Korea had some 4.17 million online securities accounts, a growth of 53 times. These accounts already accounted for 48.2% of all active securities trading accounts. Meanwhile, the monthly average online securities trading per account in 2000 was 30.94 million won, with the monthly average order number per account being 12.8 (Korea Securities Dealers Association, 2001b). In fact, a recent survey revealed that 92% of Korean retail investors preferred online trading to using traditional brokerages (*Asiaweek*, 2001).

With an online trading penetration rate in excess of 67%, Korea is the undisputed leader of Internet stock trading in the whole world. Its online trading percentage is higher than even the United States, which an online penetration rate of around 40% (Yiu, 2000). This is quite remarkable in light of the fact that the United States has a significantly longer history of discount brokerage services than Korea. Among the 13 members of ICOSA, an international securities industry association, Korea has the highest online trading percentage, surpassing second-place Canada's 40% and third-place France's 28%. Korea is also substantially ahead of high-income East Asian economies such as Japan, Taiwan, Singapore and Taiwan (Yiu, 2001).

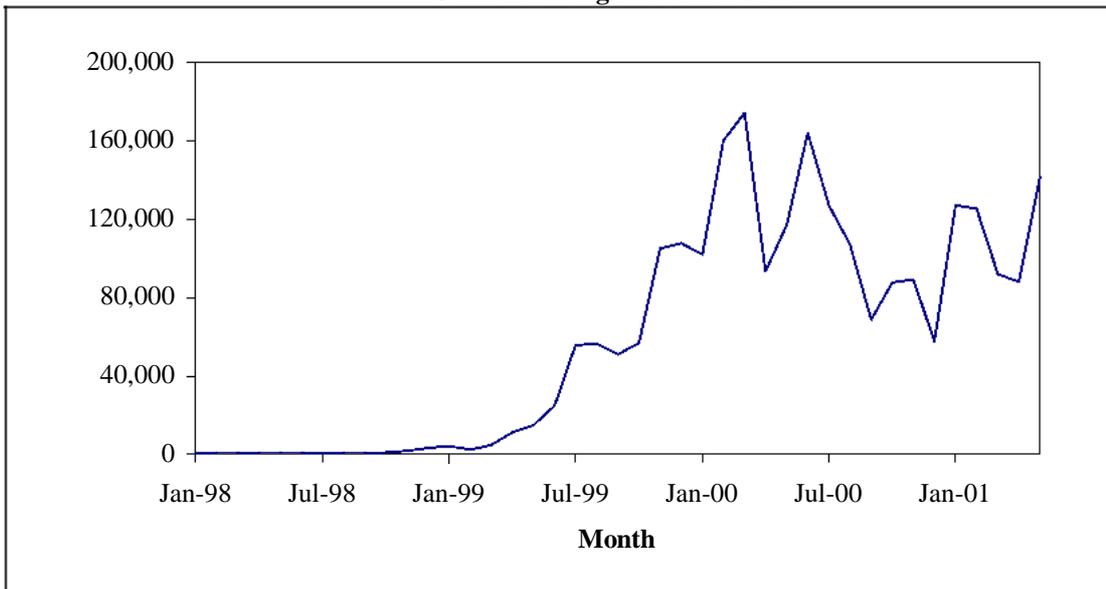
**Figure 1**  
**Online Stock Trading as Percentage of Total Stock Trading Volume**



Source:

Korea Securities Dealers Association, (2001a)

**Figure 2**  
**Online Trading Value in Korea**



Source:

Korea Securities Dealers Association (2001a)

The main part of our paper deals with the implications of this online trading boom on the retail brokerage industry in Korea. Since the Buttonwood Tree exchange that took place in New York in 1790s, the brokerage industry has undergone numerous evolutionary changes, many of them attributable to the emergence of new technologies. With the advent of Internet technologies and the subsequent Internet trading in the last few years,

a brand new industry has emerged, the Online Brokerage.

In the second section, we attempt to analyze the changing value proposition of the brokerage industry and predict what the future holds. In the third section, we examine the changing competitive environment of the industry using Porter's Five Forces model. In the fourth section, we look at how existing online brokerage

can ensure long-term sustainability in the face of tumultuous change. The fifth section concludes.

## **2. Changes in the Value Proposition of the Brokerage Industry**

At its simplest, the securities industry is composed of exchanges, clearing houses, brokerages consisting of brokers and financial advisors, sellers/borrowers, and buyers/investors. Brokerages engage in the purchase, sale, and intermediation of securities. Securities firms serve four major functions in the financial market. First, they serve as financial intermediaries, matching individual/institutional investors with individual/institutional sellers, and corporate/governmental borrowers. Second, they provide a means of pricing and valuing investments by making timely information about investments available to the marketplace. Third, securities firms furnish a vehicle for the liquidation of investors' assets, as brokers and dealers trade securities for investors efficiently. Finally, they provide investment advice and customer-tailored financial instruments.

Many securities firms serve as both brokers and dealers, with the former trading on behalf of clients and the latter trading on its own account to make a profit. Most broker-dealer firms have headquarters to handle administration, and branch offices to sell and market company services, and assist clients. The type and extent of services offered beyond brokerage and dealing activities determine what category the security firm falls under, namely full-service or discount brokerage. Full-service firms provide a range of services for both retail and institutional customers (see Figure 3 below), while discount brokers usually act as the primary access channel for retail customers to reach the stock market (see Figure 4 below).

With the advent of the Internet, the brokerage industry has shifted to a new paradigm, electronic brokerage services (henceforth e-brokerage.) E-brokerage adds a new factor to the value-proposition of off-line traditional brokerages, regardless of whether they are full-service or discount: the Internet medium (see Figure 5 below).

This medium can help the dependent investors do their own research, and get informed about new initial public offerings (IPOs). It could also provide asset management tools. All in all, the Internet makes transaction more apparent with its speed and availability. In this environment, the investors' expectation from the

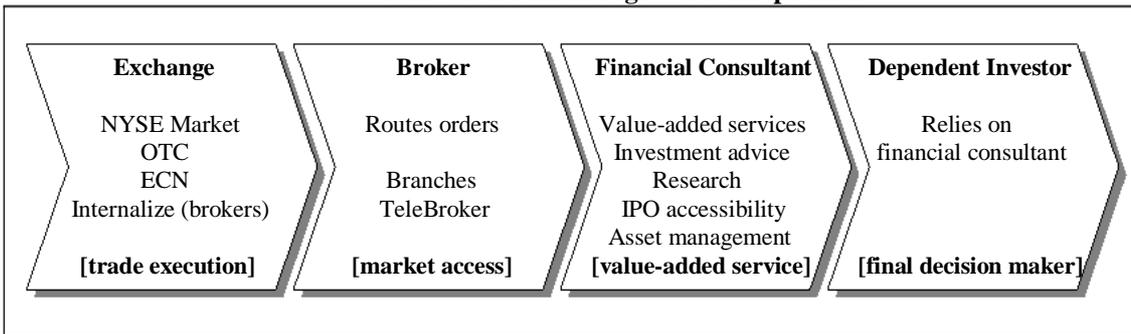
e-brokerages are more demanding than ever before. The most common belief is that e-brokerages must provide hassle-free automated transaction execution along with other products at a reduced price. Those products and services should be available 24 hours a day, seven days a week. Moreover, with the high automation capability of the medium, the services must be customised to match the tastes and styles of each investor. These could include easy and low-cost access to research reports, resource links, tools and analysis, charts and news, customizable portfolio views, and checking and banking services.

While offering new value propositions for the investors, both e-brokerage and traditional brokerage house can also benefit from the Internet. First of all, the Internet has become a new channel to acquire new customers and sell products and services. The Internet is an ideal medium to help brokerage firms to expose themselves to potential buyers globally and achieve efficient dissemination of product and service information. It expands the opportunity to participate in the customer acquisition processes and improve target customer identification. It facilitates new sales and delivery directly to consumers without time and place constraints. Online stock purchasing is a good example of a new channel that reduces transaction costs both for the seller and the buyer. The Internet also creates new products and services, such as the ability to transfer funds from bank accounts.

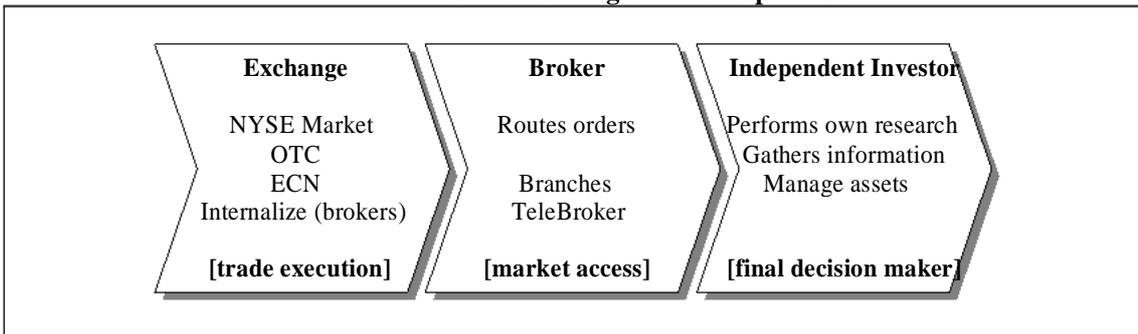
The Internet could help increase customer satisfaction as well. Because it is capable of mass customisation, the Internet allows custom marketing and personalized products, which translates into greater customer satisfaction and more transactions. Customized service requires an enriched understanding of the ways in which products are used, usage rates, and precise performance metrics, which is now possible via the Internet. Automation web sites can expand and improve customer support 24 hours a day, seven days a week.

Finally, the Internet is providing brokerages cost savings in overhead, labour, transactions, and customer services. It reduces the costs of providing customer support services by providing a cheaper communications medium (cheaper than telephone support) and lowers transaction cost by eliminating store fronts and improving business processes. Opportunities to streamline payment/receivables processes become a reality, thanks to the rapid development of online transaction technologies.

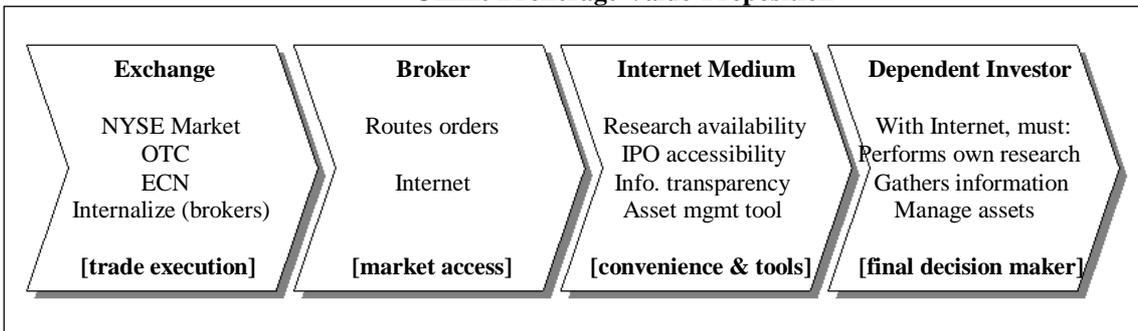
**Figure 3  
Full-Service Brokerage Value-Proposition**



**Figure 4  
Discount Brokerage Value-Proposition**



**Figure 5  
Online Brokerage Value-Proposition**



In conclusion, brokerage firms are positioned to capture a larger share of the customer's wallet. One thing appears certain: in general, e-brokerage will continue to grow in popularity (Yoo, 2001).

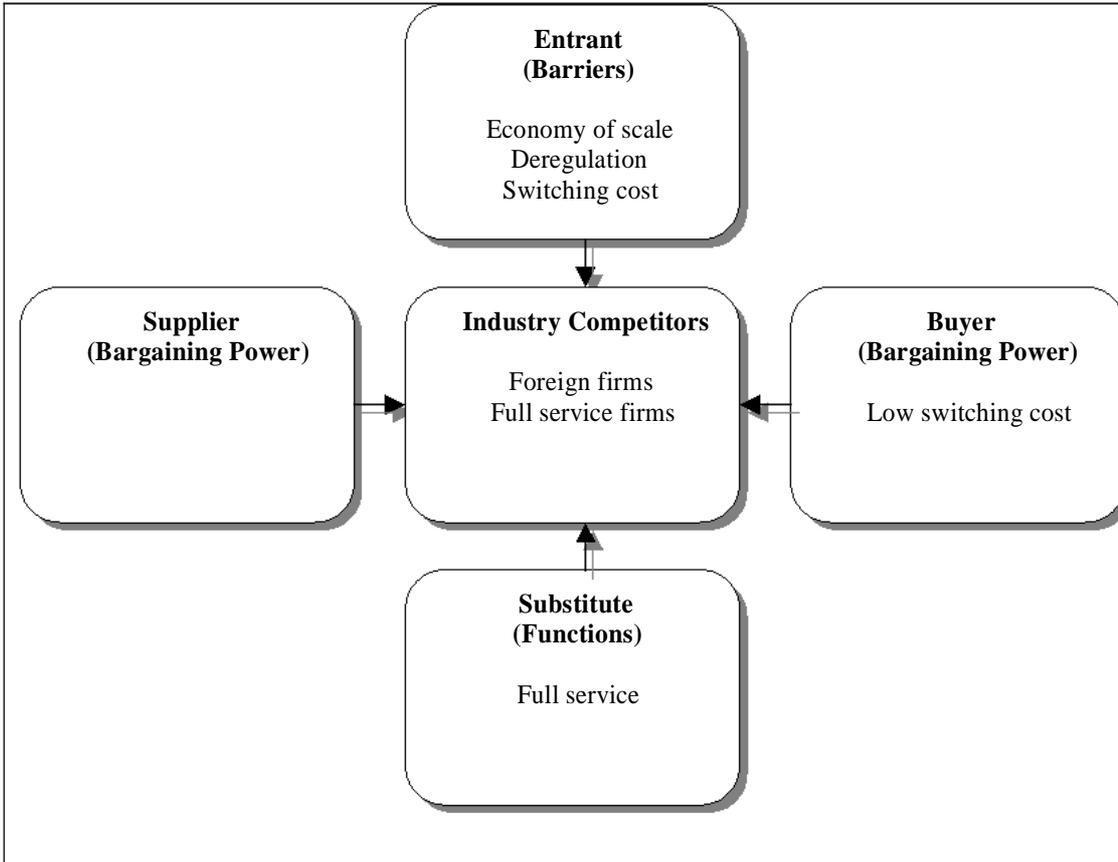
### **3. Changes in the Competitive Environment of the Brokerage Industry in Korea**

Despite the advantages of an online business model, the e-brokerages are facing many new challenges. We will analyze the changing competitive landscape using Porter's Five Forces Model (see Figure 6 below).

#### **3.1 Low Barriers to Entry Lead to More Competition**

The most important difference between e-brokers and traditional brokers is that e-brokers lack of a physical presence (including the branch office and financial consultants) and the associated costs of development such as building cost, overhead, and employee wages. The second key difference is the brokers' strategic approach. While established companies have attempted to retain an established customer base, electronic brokers must follow a customer acquisition strategy. This means they must differentiate themselves, whether through low costs or value added services (Dong, 2001).

**Figure 6**  
**Korea Retail Online Brokerage Industry Analysis**



Beyond the physical and strategic differences, e-brokers resemble discount brokers in several ways. They offer discounted prices and pass control of portfolio management to the investor and collect revenue from trade commissions, interest income, and service fees.

Competition is even more intense in the aftermath of the financial reforms that took hold after the economic crisis. The commission fee is now subject to fierce price wars between competitors. Deregulation also opens the market to global competition, allowing the participation of the foreign brokerage houses in the local market, making things even tougher for local players.

### **3.2 Customers' Greater Bargaining Power**

Brokerage service firms must be aware of the modern consumer who has exposure to the Internet and technology. He or she has greater challenge of balancing personal and professional priorities and has less time and energy to select brokerage service providers. The Internet provides access to a much wider potential client base than a physical brick and mortar structure, but also makes it much easier for consumers to compare different service providers. Consumers have both less time to devote to selection of brokerage service provider and much greater control over the

selling process. This can make the cost of attracting and retaining customers become more significant as stiff competition forces e-brokers to offer more innovative and better products and services to win business (Lim, 2001).

### **3.3 More Intense Rivalry**

E-brokers have delivered revolutionary products to the market with online trading. However, with more new participants coming to the market, it is extremely difficult for any player to differentiate itself from others through distinctive products. Moreover e-brokers are also facing increasing composition from the existing traditional full-service players, who can offer more comprehensive services for dependent investors. The inevitable maturing of the consumer market for online trading will thus force e-brokers to shift gears and move into non-trading investment business or try to appeal to a wider market.

### **3.4 Other Considerations**

The fierce competition in the market has led to a situation in which most online brokerage houses depend on fee-per-trade for their revenue. Thus, this business

model is fundamentally in conflict with customers' best interest. The incentives to provide investors with stable long-term blue-chip securities are weak when revenues increase with the frequency of transactions. Because of this, some vendors are unbundling their products and services, such as research and access to IPOs. The day traders are the exception. However, they are attracting more regulatory scrutiny, which could have negative spillover effects for mainstream brokers. In addition to those challenges, traditional brokers, who decide to jump on the e-brokerage bandwagon, face substantial channel conflict with their network of dealers and brokers.

In conclusion, there are two main implications of online trading for the brokerage industry: severe competition and pricing pressure in certain segments. This is likely to continue, as the online brokerage space becomes more crowded with new entrants and traditional brokerage firms moving online and into new segments of the market. However, growth in the number of online trades should provide volume growth. Furthermore, it is possible that some market segments may experience price increases. We foresee a divergence of business models catering to either the asset management model or the high-volume trading model (or, in some cases, both). As competition continues to heat up and more emphasis is placed on assets, not trading volume, other value-added services will become an important component of e-brokerage. Consequently, only companies who actively change their business models to adapt to the changing environment will do well (Kang K.T., 2001).

#### **4. Strategies for Long-term Success for Online Retail Brokerage in Korea**

One thing we can be certain is that the advancement of technology is going to continuously transform the brokerage. The future is going to be very different from the present. In the words of Hamel and Prahalad, failure to anticipate and participate in the opportunities of the future will impoverish the firms. In an emerging industry with no precedents, anticipating the future is an enormously complex task. To compete more effectively for the future, it is necessary to build the best possible assumption base about the future and thereby develop the prescience needed to proactively shape industry evolution. Industry foresight will give a company the potential to get to the future first and control its evolution and thereby control its own destiny (Hamel & Prahalad, 2001). In particular, the online brokerage should ask itself three essential questions. First, what new types of customer benefit should the company provides in five, ten or fifteen years? Second, what new competencies should the company build or acquire to offer the benefits to the customer? Lastly, how should it reconfigure the interface with the customer?

Realizing that the future is very different from the present, the management should be made aware that it

takes "thinking of the box" to plot the future direction. Invoking economist Joseph A. Schumpeter's notion of capitalism's "creative destruction", the management should not cling to the past but always look for ways to improve on its existing business model. It is therefore crucial that there is a management in place that understands both the trend of new emerging technologies and how the needs of customers will evolve in the future.

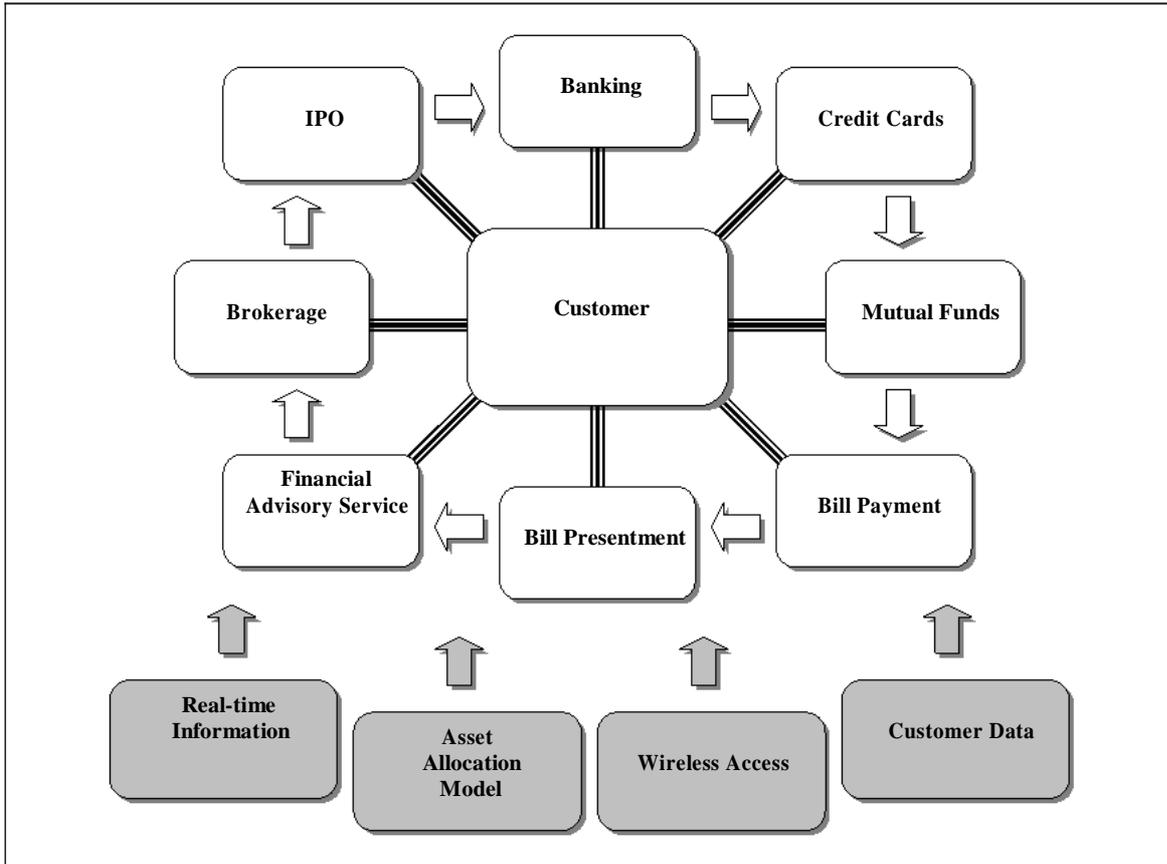
Online trading in Korea is expected to continue its growth as securities firms continue to engage in aggressive marketing, reduce commissions fees and develop advanced communication technologies. The number of new entrants coupled with the increasing use of online trading by institutional investors will also contribute to the growth of online trading. FSC anticipates that with the current razor thin commission, there will be probably a watershed of the securities business community. Many smaller and unprofitable brokers will be forced to close down. FSC has since moved to remove regulatory obstacles that limit the incentives of securities firm to go beyond merely satisfying regulatory requirements. This means shifting of their knowledge and resources from mere brokerage services and securities investment activities toward sophisticated corporate finance and investment banking activities (Jin, 2001).

Through value chain analysis, we predict that customers of the future will most likely demand the best of both worlds, that is low commissions and rich financial advisory services in a reliable and convenient transaction platform. Acknowledging that the customer is at the core of all strategies, we have developed the hub and spoke model to explore how online brokerage can excel in the long term (see Figure 7 below).

##### **4.1 Execution and Advice**

With the lowering of entry barriers and lifting of foreign participation in the brokering industry as a result of financial liberalisation, the commission rate has been facing strong downward pressure. Examples from the US market also point to the inevitable entry of the full service firms, local and foreign, to embrace the digital opportunities (*Business Week*, 2001). Online brokerage firms have to recognise that they have to offer more than low price execution to interact more meaningfully with customers. Most customers of online brokerage prefer it to the traditional broker due to lower transaction cost. However, transaction-related revenues are very volatile. To illustrate this point, the total online stock trading amount in March 2001 was down 47.1% as compared to March 2000 (Korea Securities Dealers Association, 2001b). Therefore it is critical for firms to move away from excessive reliance on brokerage transaction and more towards more stable income sources such as service fees, account fees and interest income.

**Figure 7**  
**Hub and Spoke Model with Customer as the Core**



One effective way to increase revenues from a customer is to take advantage of the entire customer-wealth cycle. E-brokers can broaden their services by improving on their financial advisory services. As a customer moves into different stages of his wealth life cycle, his investment outlook will change accordingly. The crash of the dot.com and many other technology related stocks in the last year has made many investor realise that while submitting a trade may be quick, easy and simple, the process of making sound appropriate investment decisions has not become any quicker, easier or simpler. Charles Schwab, the top U.S. discount broker, understood this principle and has moved to take advantage of the customer wealth cycle early by adding investment advisory offerings via its acquisition of U.S. Trust & Co., an old-line private client bank, and CyberCorp, a technology and day trading firm (Coffin, 2001). With this move Charles Schwab sought to cater to the needs of customers in various stages of their wealth life cycles, and continue to earn their devotion and loyalty. In fact, hybrid firms such as Schwab that provide a wider range of services at a reasonable price will experience faster growth than the no frills online discount broker or full service broker.

#### **4.2 Rise of the Assets Play**

Another important benefit of exploiting the customer's wealth life cycle is asset accumulation. Although assets may come and go in good and bad markets, assets make for a more sustainable and less volatile franchise (Meyer, 2001). As the online brokerage moves into maturity, the performance metrics is no longer the number of customer accounts. Instead it becomes the total asset volume under management. In fact, Charles Schwab had US\$219 billion in assets and collected US\$180 million of mutual fund service fees in the second quarter of 1999 alone (Junnarkar, 2001). One effective way for Korean brokerage houses to accumulate assets is to expand beyond their brokering services to include services such as bill presentment and payment, credit cards, mutual funds and access to initial public offerings (IPOs). Becoming the single source supplier for all banking and investment related products and services will enhance the stickiness of the web sites, expand customer base and increase financial leverage.

#### **4.3 Partnerships and Alliances**

We have earlier illustrated through the hub and spoke model the concept of developing products and services with the customer at the core centre. However,

few firms will have the financial strength and intellectual bandwidth to create high quality financial content across the spectrum. Instead, the brokering house should act as an aggregator and presenter of market information and products rather than a creator of content. Content – such as mutual funds, asset allocation models, and IPO access – will be created by niche players with specific expertise in those areas. A smart brokerage firm will pull the content from a variety of sources, aggregate, package and sell it at the lowest cost and highest quality. Forming strategic partnership and alliances with well-known and trusted online players can expedite the account aggregation and also lend credibility to the brokerage house.

#### **4.4 Harnessing Technology**

One advantage of the Internet is the tracking abilities that it offers. Korean brokerages should recognise that they have an enormous database on their hand – data obtained from their customers' trading behaviour and activities, such as the types of web site visits. Through advanced data mining tools, financial companies can tailor complex offerings to their customers. Companies that utilise customer data effectively can develop a customer relationship that increases loyalty and cross-selling capability.

The emergence of broadband wireless applications has opened up many new possibilities of interface between customer and the financial companies. Applications such as wireless application protocol has enabled an investor to access the latest financial information through gadgets such as mobile phones, and personal organisers 24 hours, seven days a week. Financial companies should be aware of the latest development in communication technologies and learn to exploit those technologies to their advantage.

#### **4.5 Building Brand Name**

In the U.S. context, E\*Trade has become the second largest online broker in terms of number of average daily trades, third in the number of accounts and fourth in client assets in a short span of four years. E\*Trade strategy has focused on customer acquisition and building a strong brand through aggressive advertising campaign. Its marketing budget of US\$ 300 million in 2000 is even bigger than that of Schwab, which is 11 times bigger. Similarly, other online players have also spent substantial amount on advertising. A big part of this battle is to compete for brand awareness and market share, which most believe will lead to marketplace dominance. All the online trading players aim to be the power brand that is recognized to represent the entire category of online broking. Likewise, Korean online brokers should also invest heavily in marketing to build a strong brand name to capitalize on the growth of the equity culture in Korea after the economic crisis.

But having said that, the Korean online brokerage should not make the same mistake as their counterparts

in the U.S. One of the major complaints against the U.S. online brokers is the frequent disruption of service, which contradicts their advertising message of fast and reliable system. In 1996, AOL launched an aggressive advertising campaign yet only added a modest number of modems to service these new online accounts. As a result, an overwhelming number of new subscribers were unable to access to AOL and this created a huge public backlash against the company (Spitzer, 2001). Korean online brokerage players should make sure that they have sufficient system capacity to serve their customers before embarking on any big advertising campaign.

#### **4.6 Summary of Strategies for Online Securities Firms**

We have thus suggested that an online broker should provide its customers with services based on their needs. As customer needs change through his wealth life cycle, the financial company will replace one offering shown in the hub and spoke model with another shaped by new efficiencies and demand. Technological innovations permit the financial intermediaries to reach out into the market place and provide these services at a lower price than building the offering themselves. Strategic alliances and partnership also allow the companies to be nimble and react fast to customer changing needs and demands at a lower cost and more efficiently than competitors. In the long term, such efficiencies and cost reduction will translate into a sustainable competitive advantage for the company (Kang K.T., 2001).

#### **5. Concluding Remarks**

The emergence of Internet technology and the many innovative applications that are built on its foundation has rewritten many existing business rules and assumptions. In particular, the brokerage industry has undergone a major shake up in the last decade. The introduction of online brokerage has redefined the rules of the game and that has put many traditional brokerages scrambling for solutions or facing extinction. Such heightened competitive pressures are very much in Korea, which has experienced explosive growth of online stock trading and is now a world leader in this area.

The focus of our paper has been the impact of Korea's online trading boom on the competitive environment facing brokerage firms and their potential strategic responses. Since it entails a combination of low entry barriers for new e-brokers and customers who have more information and are therefore more demanding, online trading creates intense competitive pressures. Only companies who actively change their business models to adapt to the changing environment will make the grade. More specifically, the most viable business models probably involve focusing more on financial advice and other customized, fee-based services and away from high-volume trading. Brokers should

provide such services throughout the customer's wealth life cycle, which entails different needs at different times.

With the proliferation of Internet, online trading will eventually spread to all stock markets, the only difference being the timing and magnitude of penetration. Our paper will be useful to anyone who wishes to have a better understanding of online trading. In particular, we hope our section on long-term strategies for online brokerage will provide valuable suggestions to online brokers in other markets since they will face the same kind of intense competitive environment associated with the advent of online trading in Korea.

## References

- [1] *Asiaweek*, "Not All Share and Share alike", <http://www.asiaweek.com/technology/2000/0811/com.e-vesting.html>, 20 March 2001.
- [2] *Business Week*, "Merrill's Battle", [http://www.businessweek.com/1999/99\\_46/b3655001.htm](http://www.businessweek.com/1999/99_46/b3655001.htm), 12 March 2001.
- [3] Coffin R., "Technology Transforms the Securities Industry", [http://www.pwcglobal.com/extweb/pwcpublishations.nsf/4bd5f76b48e282738525662b00739e22/f2328b0ba564ad95852569c9005bb30d/\\$FILE/3974perspectives\\_issue3\\_techtransforms\\_10-17.pdf](http://www.pwcglobal.com/extweb/pwcpublishations.nsf/4bd5f76b48e282738525662b00739e22/f2328b0ba564ad95852569c9005bb30d/$FILE/3974perspectives_issue3_techtransforms_10-17.pdf), 1 May 2001.
- [4] Hamel G. and C.K. Prahalad, "Competing for the Future", HBS Press, Boston, 2001, p.79.
- [5] Jin B., "Facts and Implications of Online Trading in South Korea", 28 June 2001.
- [6] Junnarkar S., "Online Brokerages: Grow or Wither?", <http://yahoo.cnet.com/news/0,10000,0-1007-200-346712,00.htm>, 20 April 2001.
- [7] Kang K.T., "Online Stock Trading in Korea and E-trade's Strategies", 28 June 2001.
- [8] Korean Industry Update, "Internet January's Online Stock Trading Hits US\$100 Billion", 5 February 2001a, p.2.
- [9] Korea Securities Dealers Association, "Monthly Online Securities Trading in Korea", <http://ksda.or.kr/portfoliokorea/index.cfm>, 15 June 2001a.
- [10] Korea Securities Dealers Association, *Online Trading In Korea*, Seoul, April 2001b.
- [11] Lim J.S., "Online Stock Trading in South Korea and SK's Strategies", 29 June 2001.
- [12] Meyer L., "Will Online Brokerage gets Swallowed?", [http://www.redherring.com/index.asp?layout=story&channel=20000002&doc\\_id=185001238](http://www.redherring.com/index.asp?layout=story&channel=20000002&doc_id=185001238), 25 April 2001.
- [13] Spitzer E., "Online Brokerage Industry Report", [http://www.oag.state.ny.us/investors/1999\\_online\\_brokers/brokers.html](http://www.oag.state.ny.us/investors/1999_online_brokers/brokers.html), 16 April 2001.
- [14] Yiu E., "Online Broking Tally Sets Fast Growth Pace", *South China Morning Post*, 2 January 2001, p.BP2.
- [15] Yiu E., "Price War Looming for Online Traders", *South China Morning Post*, 1 December 2000, p.BP1.
- [16] Yoo N.G., "Online Stock Trading in South Korea and Hyundai's Strategies", 29 June 2001.

# Theory Modeling and Empirical Evidence for Value-at-Risk based Assets Allocation Insurance Strategies

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## Abstract

Constant Proportion Portfolio Insurance (CPPI) is the most popular portfolio insurance strategy using hedging strategy to protect principal while a wave upward or downward trend in the market is noted. Nevertheless, since the original CPPI was proposed, its performance has been limited to relevant parameters of strategy. And since there is no clear, definite and systematic rule of decision has get been proposed, it also has unstable performance and worse upside capture, especially for the multiplier ( $M_t$ ) in model parameters, it has far great influence to end-of-period return. If  $M_t$  can be decided with its initial value setting and dynamic tuning via certain appropriate approach, under a decent mechanism of market timing selection, the strategy can therefore acquire excess return of min-max operation due to sharp improvement of upside capture, and also can provide hedging function within the insured volume when the market declines. This paper presents a systematic method using the value-at-risk control method to dynamically adjust the CPPI strategy parameter  $M_t$ , called asset allocation insurance strategy value-at-risk based asset allocation insurance strategy model (VALIS). We proof that the proposed model is a dynamic asset allocation insurance strategy, which is conservative but also aggressive; and shows that it is in compliance with the characteristics of idea portfolio insurance strategy, and is feasible and effective. From an empirical study of the Pan-Pacific market, we found that in any type of market or trend it is clearly better than the major benchmark indices, and it outperform other traditional portfolio insurance strategy.

## 1. Introduction

In general, portfolio insurance strategies can be categorized into two types: the first type is the portfolio insurance strategies which do not involve underlying options including Buy and Hold, B&H [1], Constant Mix, CM, Constant-Proportion Portfolios Insurance, CPPI [2], Time-Invariant Portfolio Protection, TIPP, [3] etc. The second type is the Option-Based Portfolio Insurance (OBPI) which is derived from the basis of option pricing

formulas, such as PBPI (Participation-based Portfolio Insurance), CBPI (Capped-Based Portfolio Insurance), Covered Put, Synthetic Put and Dynamic Hedging, etc. In the aforementioned portfolio insurance strategies, based on the considerations to avoid the misallocation effect, mispricing effect, insurance performance uncertainty effect [4], inadequate substitution of financial instruments and sour liquidity, etc., which are derived from over dependence on complicated option evaluation models [5], basis risk and risk of missing pricing of derivatives, interest rate and transaction cost modified bias [6], variance estimation error, etc., though the constant superior strategy is not concluded yet, the proportion protection insurance strategy, which is relatively simple and easy to operate and maintain, has become the rebalance strategy which is preferred by the majority of conservative fund managers and asset allocation management institutions [7].

The constant proportion protection insurance strategy features the effects of buy-low and sell-high. If there is sign of the trend and when there is judgment on whether there is rise or fall in the market, it outperforms other similar insurance strategies. However, since the constant proportion protection insurance strategy mode was proposed, its performance has been limited the parameters of model which lack precise and systematic determinant rules, thereby leading to instability and poor upside capture. Especially, the parameter in model of strategies, Multiplier,  $M_t$ , affect the entire accumulated profit of the rebalance strategy of enormously. If  $M_t$  can be applied via suitable method to determine its initial value and dynamic tuning, then because of the large enhancement of upward catching rate, it will enable that strategy to obtain excess return of Min-Max operation. At the same time it also possesses risk prevention function provided under insured amount when the market drops.

Thus, the original constant proportion protection insurance strategy assumes that  $M_t$  is a constant value. For works of later related scholars, practical market operators and research reports etc, mostly they based on experience to conduct rough estimate so as to establish the

parameter setting of strategy model. Till now there is still not one (General) setting or adjustment method [8]. As the portfolio insurance strategy must possess both capital insurance and profit making property, therefore the consideration of this property is to bring in estimation on the maximum loss of a certain future period to assets allocation strategy. Then by means of Value-at-Risk control model dynamic tuning  $M$ , and by proving that the proposed dynamic tuning strategy model possesses also excess return obtained from active operation as well as essentials of insurance for avoidance of downside risk insurance.

This research combines risk metric method and historical data simulation method as the Value-at-Risk estimating model. In empirical research, the result proves the robustness and validity of the proposed strategy model. The conclusions of results also show proof and discussion that supports this paper and the same time it is discovered that it also possess considerably high real world market operation feasibility.

This paper is organized as follows: in the first section, we describe the research background and motives of this research, and present a complete paper review; in the second section, we first introduce the Value-at-Risk control model, which is quoted in the paper, as the deductive theory basis of the proposed model and as the basic concept of the empirical study; from the third section, we start to conduct the deduction and verification of the proposed Value-at-Risk assets allocation insurance model, and also begin to introduce the Value-at-Risk concept into the portfolio insurance model; We then apply the deduced model in the fourth section and conduct market empirical study and analysis; finally, in the fifth section, we present the conclusions and discussions of this research; in the final part, we present our views in the future developments and visions, offering an arena to be further developed and discussed by subsequent researchers. In the following we begin by explaining the Value-at-Risk estimation method adopted by this research.

## 2. The Adoption of the Value-at-Risk Measurement and Evaluation Methods

### 2.1 The Value-at-Risk Measurement

In 1730, Abraham de-Moivre first proved: "Within a preset error range, the observation values of a random sampling are presented in a bell-shape curve, with the right and left wings being symmetrical and the values averagely being distributed in the both sides of the mean. It is so called the Normal Distribution." And de-Moivre further established the concept of standard deviation. The two concepts are now generally referred to the Law of Average, which has placed a significant foundation for the development of the modern quantitative risk.

The Value-at-Risk is the methodology proposed by modern statistics, and has been widely applied as a tool to measure risk of late. Its main concepts are also originated from the Law of Average. Its definition is stated as follows:

The approaches adopted by the study are briefly illustrated as follows:

### 2.2 Parametric Form (Analytic Variance-Covariance)

Currently the most frequently used by the industries and the most well known solution is the Risk Metrics developed by JP Morgan. The assumption premise is the portfolio return is a normal probability distribution, and its relation with the change of risk factors is linear. Thus, the Value-at-Risk of the portfolio can be obtained by calculating the standard deviation and the association degree of the risk factors. Consequently, with only two presumed simple linear portfolios, which are in accordance with the aforementioned such as negotiable securities, spot and forward exchanges and notes etc., a crisp value can be generated through the said method. Its advantages are: (1) there is no need of any pricing model; (2) market data can be accessed at any time. And its disadvantages include the difficulty to conduct a sensitivity analysis etc.

Assuming the assets in a portfolio features a normal distribution return, the combination of the normal distribution variables can be defined by

$$aX + bY \quad (1)$$

Where,  $a, b$  are the Mark to Market, MTM, of the assets  $X, Y$ ; and  $X, Y$  are the securities which feature a normal distribution return, hence the standard deviation of the combination can be defined by

$$\sigma_p = \sqrt{a^2\sigma_x^2 + b^2\sigma_y^2 + 2ab\rho_{xy}\sigma_x\sigma_y} \quad (2)$$

## 3. The Theory Modeling and Verification of Dynamic Asset Allocation Strategy

In this section, we first introduce the Value-at-Risk theorem into the insurance strategy, and then verify whether the strategy formed by the established model is in compliance with the two properties of an ideal investing portfolio insurance strategy proposed by Rubinstein.

### 3.1 The introduction process of VALIS risk model

Let  $M$  be multiplier. In time  $t$ , the insurance premium  $F$  can be demonstrated as

$$F = F_0 e^{rt} \quad (3)$$

where  $r$  represents the risk free rate or treasure bond (or notes);  $F_0$  is the initial insurance premium. If we calculate the payoff in time  $t$ , then

$$W(t) = F + [W(t) - F_0] \left(\frac{S}{S_0}\right)^{M_v(t)} e^{(1-M_v(t))(r+0.5M_v(t)\sigma^2(t))} \quad (4)$$

Where,  $W(t)$  is the wealth in time  $t$ ;  $W$  is the initial wealth;  $S$  is the stock price in time  $t$ ;  $S_0$  is the initial stock price level. Then the exposure,  $V(t)$ , of risky assets can be demonstrated as

$$V_s(t) = M_v(t)[W(t) - F(t)] \quad (5)$$

Considering the situation where no leverage is available, then Equ. (5) can be demonstrated as Equ. (6)

$$V_s(t) = \text{Min}\{W(t), M_v(t)[W(t) - F]\} \quad (6)$$

Considering the market risk [9], if  $\Delta P(\Delta t)$  is the asset position price volatility volume during time length  $\Delta t$ , then if we demonstrate the Cumulative Distribution Function, CDF, of  $\Delta P(\Delta t)$  as  $F_{\Delta P}(x)$ , thus in the Probability,  $P$ , the Value-at-Risk of Long Position during  $\Delta t$  can be shown as the following equation:

$$P(t) = \mathbb{P}[\Delta P \leq t \mid \text{VaR}(t)] = F_{\Delta P}(\text{VaR}(t)) \quad (7)$$

The VaR of Equ. (7) in this research is based on the RiskMetrics™ method developed by J.P. Morgan [10][11]. Assuming the continuously compounded daily return of the assets portfolio possessed follows the conditional normal distribution, if daily log return is denoted as  $r(t)$  and the information set acquired in time  $t-1$  as  $\phi(t-1)$ , under the hypothesis that there is no drift phenomenon in random walk, then  $r(t) \mid \phi(t-1)$  can be demonstrated as Equ. (8)

$$r(t) \mid \phi(t-1) \sim N(\mu(t), \sigma^2(t)) \quad (8)$$

Where,  $\mu(t)$  is conditional mean, and  $\sigma^2(t)$  is conditional variance of  $r(t)$ .  $\mu(t)$  and  $\sigma^2(t)$  can be described using a simple model as shown in Equ. (9).

$$\mu(t) = \alpha_0 + \alpha_1 r(t-1), \sigma^2(t) = \alpha_2 + \alpha_3 r^2(t-1), 1 > \alpha > 0 \quad (9)$$

Where the implied daily spot price  $P(t)$  is log value, i.e.  $\ln(P(t))$ , which satisfies IGARCH(1,1) (Integrated Generalized Autoregressive Conditional Heteroscedastic) (Engle, 1982; Bellerose, 1986, 1992, 1994; Nelson, 1991; Tsay, 1987) Process different

equation  $P(t) - P(t-1) = a(t) + \sigma(t)\varepsilon(t)$ , where  $\{\varepsilon(t)\}$  is iid (independent and identically distributed) random variable series; and  $a_0 > 0$ , mean is equal to one and variance is equal to one. From the property of IGARCH model,  $h$  period log return from time  $t$  to time  $t+h$  can be denoted as

$$r_h(t) = r(t+h) + r(t+h-1) + \dots + r(t+1) \quad (10)$$

Thus, from Equ. (10), we know that  $r_h(t) \mid \phi(t)$  in Equ. (9) is a normal distribution, and its mean is equal to be 0. As for  $\sigma_h^2(t)$  under the assumption that  $\varepsilon_t$  is independent, we can acquire as shown in Equ. (11)

$$\sigma_h^2(t) = \text{Var}[r_h(t) \mid \phi(t)] = \sum_{i=1}^h \text{Var}[r(t+i) \mid \phi(t)] \quad (11)$$

Where  $\text{Var}[r(t+i) \mid \phi(t)] = E[\sigma^2(t+i) \mid \phi(t)]$  solved recursively.

Applying  $r(t-1) = a(t-1) + \sigma(t-1)\varepsilon(t-1)$ , Equ. (9) can be rewritten as below:

$$\sigma^2(t) = \sigma^2(t-1) + (1-\alpha)\sigma^2(t-1)(\varepsilon^2(t-1) - 1), \text{ for } \forall t \quad (12)$$

Since  $E[\varepsilon^2(t+i) - 1 \mid \phi(t)] = 0$ , for  $i \geq 1$ , this Equ. (12) can be formulated as

$$E[\sigma^2(t+i) \mid \phi(t)] = E[\sigma^2(t+i-1) \mid \phi(t)], \text{ for } i \geq 2 \quad (13)$$

Then from Equ. (18), we can estimate  $\sigma^2(t+1)$  of next period in Equ. (14), and  $\text{Var}[r(t+i) \mid \phi(t)] = \sigma^2(t+1)$ , for  $i \geq 1$  we can conclude as below

$$\sigma_h^2(t) = h\sigma^2(t+1) \quad (14)$$

Referring to Equ. (8), we can infer as below

$$r_h(t) \mid \phi(t) \sim N(0, h\sigma^2(t+1)) \quad (15)$$

Thus, the log return conditional standard deviation of  $h$  period can be denoted as

$$h^{1/2}\sigma(t+1) \quad (16)$$

Thus, in Long Position, if the probability is set to be 5%, then we can acquire that  $\lambda_1 = 1.65$ , where  $l = 0.05$ . If we want to estimate the Value-at-Risk after  $h$  period,  $\text{VaR}_h$  we can denote  $\text{VaR}_h$  whose mean equal to 0 and standard deviation is  $\sigma(t+1)$  as

$$\text{VaR}_h(t+1) = \lambda_1 h^{1/2} \sigma(t+1) A, \quad A: \text{long position} \quad (17)$$

If we hold more than k types of asset positions and the return is likely to feature cross-correlation, then we estimate the overall  $\text{VaR}_h(t+1)$  as Equ. (18)

$$\text{VaR}_h(t+1) = \left[ \sum_{i=1}^k \text{VaR}_i^2(t) + 2 \sum_{i<j}^k \rho_{ij} \text{VaR}_i(t) \text{VaR}_j(t) \right]^{1/2} \quad (18)$$

Where,  $\rho_{ij}$  is the correlation coefficient among assets; i, j represent different assets.

If we consider there is a drift phenomenon in random walk, then Equ. (17)  $\mu_h(t)$  must be modified as

$$\left| \mu_h(t) - \lambda_1 h^{1/2} \sigma(t-1) \right| \quad (19)$$

Equ. (18) should be modified as well following Equ. (18).

Thus from Equ. (5), in time t, holding risky assets,  $V_s(t)$  and risk free assets,  $V_b(t)$ , and set  $W(t) = V_s(t) + V_b(t)$ , then we can acquire

$$\begin{aligned} V_s(t) &= \text{Min}[M_v(t-1) * (V_s(t-1) + V_b(t-1) - F)] \\ V_b(t) &= W(t) - V_s(t) \end{aligned} \quad (20)$$

With the introduction of Value-at-Risk into Equ. (17) or Equ. (19), we can formulate the Value-at-Risk dynamic asset allocation strategy model as shown in Equ. (21)

$$V_s(t) = M_v(t)(W(t) - F) \quad (21)$$

$$\begin{aligned} M_v(t) &= [W(t) - \text{VaR}(t)] / [(V_s(t) + V_b(t)) - F] \\ &= [W(t) - \lambda_1 h^{1/2} \sigma(t) W(t)] / [W(t) - F] \\ &= W(t) [1 - \lambda_1 h^{1/2} \sigma(t)] / [W(t) - F] \end{aligned} \quad (22)$$

With the same reason we can prove that risk consideration can be introduced into Equ. (18) and we can formulate as per Equ. (22)

$$\begin{aligned} M_{v,d}(t) &= W(t) \left[ 1 - \left( \sum_{i=1}^k \text{VaR}_i^2(t) + 2 \sum_{i<j}^k \rho_{ij} \text{VaR}_i \text{VaR}_j(t) \right)^{1/2} \right] \\ &= W(t) \left[ 1 - \left( \sum_{i=1}^k \lambda_i h^{1/2} \sigma_i(t) A \right)^2 + 2 \sum_{i<j}^k \lambda_i \lambda_j h^{1/2} \sigma_i(t) \sigma_j(t) - \lambda_1 h^{1/2} \sigma_j(t) \right]^{1/2} \end{aligned} \quad (23)$$

Readers can also refer to Theorem 1, Chebyshev's Theorem, to decide  $\lambda_1$  according to confidence interval.

Of course, the empirical rule or so-called 68-95-99 rules can also be a rough estimation method.

[Theorem 1] Proportion (or fraction) of any data gathered together and fell on the mean plus or minus x proportions (or fraction) within the standard deviation

shall have at least  $(1-1/x^2)$ , where x is any positive number larger than one.

### 3.2 Verification of Rubinstein's Idea Portfolio Insurance Properties of VALIS

According to Rubinstein (1985) points out that idea portfolio insurance should feature two properties. We hereby verify VALIS proposed by this research as follows:

Property 1:

Under idea portfolio insurance, the probability of suffering loss from bottom breaking is equal to zero.

Proof:

From Equ. (20), we introduce Equ. (23) into it and it becomes

$$V_s(t) = \text{Min}[M_v(t-1) * (V_s(t-1) + V_b(t-1) - F), FM_v(t)(M_v(t) - F - \lambda_1 h^{1/2} \sigma(t))^{1/2}] \quad (24)$$

Thus, from Equ. (24), investing risky assets in the worst case is equal to the security position of an underlying portfolio plus an insurance policy that is guaranteed not to suffer loss, that complies the property 1. It is hereby proved. (Q.E.D.)

Property 2:

The return of the said position totally depends on the end value of the underlying portfolio, and is irrelative with the spot price before expiration of the underlying portfolio.

Proof:

From Equ. (23), we can acquire

$$\begin{aligned} M_v(t)(W(t) - F) &= W(t) [1 - \lambda_1 h^{1/2} \sigma(t)] \\ W(t) [M_v(t) - F - \lambda_1 h^{1/2} \sigma(t)] &= FM_v(t) \\ W(t) &= FM_v(t) / [M_v(t) - F - \lambda_1 h^{1/2} \sigma(t)] \end{aligned} \quad (25)$$

From Equ. (25), it is proved that in the proposed strategy model, the holding return is irrelative with the spot price before expiration of assets allocation portfolio. (Q.E.D.)

3.3 The property is comparatively traditional that by means of options-basis insurance strategies it possesses Floor- Breaking moderation effect and occurrence probability

The operation of static portfolio insurance and dynamic portfolio insurance strategy mainly arises from the Black-Scholes model. Nevertheless, in the Black-Scholes model, one of the important assumptions is the relative price of risky assets, such as stocks.  $\ln(R/P-1)$

must demonstrate the lognormal distribution model and no serial independence under lognormal distribution model, and spot price variation behaviors are continuous, i.e. minimal volatility. Thus, there should also be huge jump spot price variation behaviors. So, the investing portfolio insurance strategy which is options-basis can be effective; on the contrary, if spot price often moves up and down sharply or even comes to a crash, then the function of investing portfolio insurance strategy model will drop down more or even the effect will be lost, Floor-breaking. As shown in the below equation, the insured portfolio, DPI, under dynamic insurance strategy, is composed by the risky assets,  $S$ , and the loan fund,  $P$ .

$$\begin{aligned}
 \text{DPI} &= S + P \\
 &= S[-N(-d_1)]S + N(-d_2)Ee^{-rT} \\
 &= [1 - N(-d_1)]S + N(-d_2)Ee^{-rT} \quad (26) \\
 &= W_1S + W_2Ee^{-rT}
 \end{aligned}$$

Where,  $d_1 = [\ln(S/E) + (r + 0.5\sigma^2)T] / \sigma T^{1/2}$ ;  $d_2 = d_1 - \sigma T^{1/2}$ ;  $\sigma^2$ : variance of strike assets price;  $T$ : Put Option contract expiration Annualized length;  $r$ : continuous compound rate, risk-free Rate;  $E$ : exercise price;  $N(-d_1)$ : under accumulated standard normal distribution, the probability from  $-\infty$  to  $-d_1$ ;  $N(-d_2)$ : under accumulated standard normal distribution, the probability from  $-\infty$  to  $-d_2$ .

$W_1$  and  $W_2$  are the weights, percentage of the risky assets,  $S$ , and the loan fund,  $P$ , respectively, and have to be adjusted at any time following the variation of the portfolio value and time. When the downward adjustment variation of  $S$  is closing to zero,  $S \rightarrow 0$ , then  $d_1 \rightarrow -\infty, d_2 \rightarrow -\infty$ . Thus,  $N(d_1) = N(-\infty) = 0, N(-d_2) = N(\infty) = 1, W_1 = 0, W_2 = 1$ . Therefore, from Equ. (26), when  $S \rightarrow 0, T > 0$ , Floor is  $Ee^{-rT}$ ; when  $T = 0, \text{DPI} \geq E$ . When there is any major variation to  $S$ , then DPI will not be able to adjust  $S$  position to  $P$  in time and thus face the danger that insurance premium breaks bottom in the beginning of the period.

However, in the VALIS model proposed in this research, because for the future portfolio value, the risk has been introduced into the insurance model by means of estimating Value-at-Risk. Thus, facing volatile circumstances, the model will be able to provide the protection and enhancement of insurance function against huge variations, and such enhance arises from the risk consideration of portfolio value adjustment to lower the short-term urgent demand on liquidity. For example, on Oct. 19, 1987, the United States stock market indexes dropped sharply, and the traditional portfolio insurance strategies all failed. The main reason is inadequate consideration of portfolio value risk that caused the

inability to buy in or sell out, thereby failing to protect the invested principal.

#### 4. Empirical Research and Analysis

The empirical research is composed by two parts. The first part is to conduct test on simulated normal status return data. The second part is to operate based on Taiwan weighted index as the asset portfolio insurance underlying content.

##### 4.1 Simulated Random Normal Return

Firstly, test is conducted based on the simulated return data generated by random method under normal distribution. Total observed return data is 112 sets ((Rand(.)-0.5)\*0.5). The descriptive statistical excerpt of return is as Table 1:

Table 1 Statistical excerpt description of return data

	Mean	Standard Deviation (S.D.)	Kurtosis	Skewness	Mean Confidence Interval (95%)
Random return	0.00348387	0.12930241	0.03186368	0.03186368	0.02421063
	6		2	2	5

Set wealth as 100, insurance premium is 80, insurance tool including stocks,  $W_1$  and risk free assets, fixed income securities, or bond,  $W_2$ , initial weights are set as  $W_1=0.6, W_2=0.4, \lambda_1 = 0.65, h = 3$ , rebalance frequency is adjusted daily, data frequency is simulated random daily return data, insurance period is the entire return observations data. Observe the multiplier,  $M_t$ , If insurance period based on experience value is set as  $M_v = 2$  and  $M_v = 3$  respectively, and  $M_t$  turning rule of the proposed VALIS in this research, then it can be clearly seen that  $M_t$  turning rule of VALIS is superior than fixed multiplier rules set in CPPI. In this case study, in respect of its performance in its insurance period, its rebalance strategy is shown in Figure 1

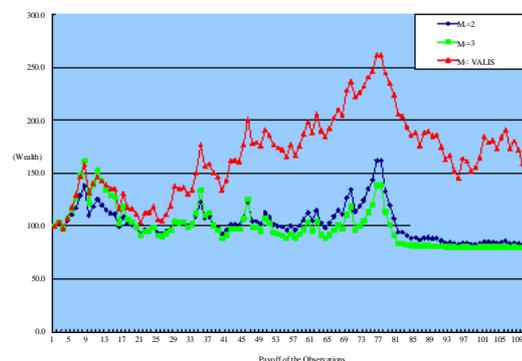


Fig. 1 Comparison of performance of  $M_t(t)$  tuning rule of VALIS and fixed multiplier rebalance strategy during the insurance period

In Figure 1, it is not difficult to discover that the  $M_i(t)$  turning rule of VALIS actually went through the estimate on the future Value-at-Risk. In respect of upside, the upside capture can be enhanced and furthermore the insurance performance can be greatly enhanced and that is the main source of excess return. In respect of downside, position can be adjusted earlier through Value-at-Risk estimation so as to avoid loss continuously due to dropping trend. This empirical study also tried comparisons between various random return types and between different kinds of fixed multiplier setting and the results tends to be uniform. That means the method of fixed multiplier has no significant difference and it also shows that there is actual proof and support on the thinking of induction of Value-at-Risk into insurance strategy. Coping with the rebalance performance in Figure 1,  $M_i$  turning rule value of tuning process and insurance period return observation data are in Figure 2

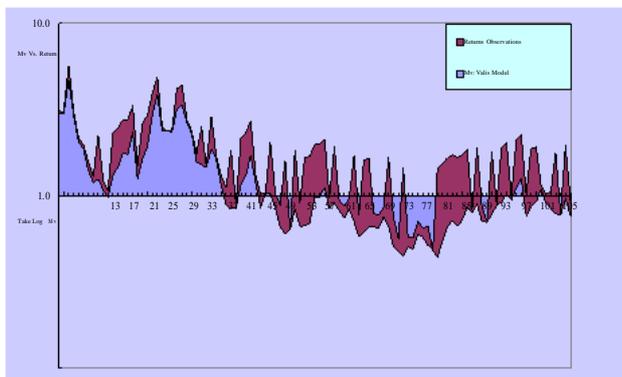


Fig. 2  $M_i(t)$  tuning rule of  $M_i(t)$  tuning process and insurance period return observation data display

Contrary to Figure 2.2,  $M_v(t)$  tuning rule of Value-at-Risk calculation and  $M_i(t)$  tuning process display is in Table 2. Table 2 shows related data of VALIS strategy applied in actually proved cases.

Table 2 Summary of VALIS strategy relevant parameters adjustment process

VALIS Strategy Model			
Return[R(t)]	VaR(t) (95%)	$M_i(t)$	Wealth[W(t)]
0.096548069	--	3.0	100.0
0.063129099	--	3.0	103.8
-0.080851495	0.2	4.7	98.0
0.174454076	0.2	2.9	107.4
0.097807636	0.2	2.1	118.0
0.106811134	0.1	1.9	129.6
0.166378286	0.1	1.4	146.7
0.091646545	0.1	1.2	158.1
-0.244630284	0.4	1.2	131.2
0.144857928	0.3	1.1	140.1
VALIS Strategy Model			
Return[R(t)]	VaR(t) (95%)	$M_i(t)$	Wealth[W(t)]

0.088742409	0.3	1.0	146.7
-0.058244264	0.2	1.3	142.5
-0.061619378	0.1	1.5	138.8
-0.041917043	0.0	1.8	135.5
-0.006938966	0.0	1.7	134.9
-0.197190979	0.2	2.3	115.8
0.241696074	0.4	1.3	130.8
-0.112041948	0.4	1.6	117.5
-0.026445139	0.3	1.9	116.3
-0.073885766	0.1	2.9	111.9

Final performance of various types of portfolios insurance strategy model with same properties are shown in Figure 3 and from the results it shows that VALIS has quite a good rebalance performance.

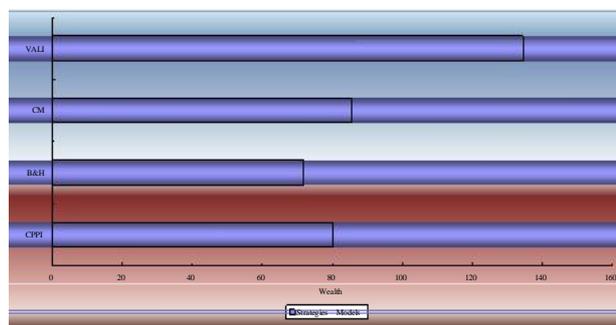


Fig. 3 Final performance comparison between operations of various types of investment group insurance strategy model

#### 4.2. Evidence from Pan-Pacific Markets

This section illustration the performance while investigating various assets in PanPacific markets. The comprehensive results show the proposed VALIS model outperforms other insurance strategy models.

The insurance period is 12 months (commencement date: 1994/01/04 ~ expiry date: 1995/01/04) and total number of business day is 244 business days. Wealth is set at 100, insurance premium is 80, insurance instruments including stocks,  $V_s$ , and risk -free asset or fixed income securities: bond,  $V_b$ , initial weights are set at  $W_1=0.6$ ,  $W_2=0.4$ ,  $\lambda_1 = 0.65$  and rebalance frequency shall be adjusted daily and insurance period covers all return observation material. Comparisons of annualized return between difference strategy models around insurance period is shown in Table 3:

Table 3 Comparisons of annualized return between difference strategy models

Annualized return for various strategy models				
Bloomberg Code	VALIS	CPPI	Constant -Mix	B & H
Japan	10.9%*	6.1%	10.1%	9.8%
$V_s$ (NKY)	$V_b$ (JPMUJPN)			
Hong Kong	12.2%*	-13.6%	-20%	-18.4%
$V_s$ (HSI)	$V_b$ (JPMUJPN)			
Annualized return for various strategy models				
Bloomberg Code	VALIS	CPPI	Constant -Mix	B & H
Korea	16.3%*	13.0%	13.4%	12.8%
$V_s$ (KOSPI)	$V_b$ (JPMUJPN)			
Taiwan	6.1%*	0%	5.0%	4.2%
$V_s$ (TWSE)	$V_b$			

PS. 1.Data Resource: Bloomberg (daily).  
2. Symbol \* denotes outperforms.

## 5. Conclusions

In respect of theorem model establishment, this research infers the concept of Value-at-Risk into the portfolio insurance strategy model VALIS so as to strengthen upside capture and through Value-at-Risk the future can be estimated conservatively and when the market is facing large fall, it will have better bottom breaking protection effect. In the essay, the characteristic of idea portfolio insurance proposed by Rubinstein is utilized to prove that VALIS conforms to the requirement of capital insurance strategy. In this empirical research, VALIS is being utilized to compare with famous traditional portfolio insurance strategy such as fixed multiplier of CPPI, B&H, CM so as to evaluate its performance.

In regard to the adoption of Value-at-Risk model, as appropriate selection has to be conducted based on investment underlying, amongst present several tens of values in risk calculation methods, each has its merits and demerits. Therefore, this essay has considered the application of the practicality of VALIS that the J.P. Morgan guidepost is considered for decision of proceeding. For induction and proof of other various types of Value-at-Risk, it can be based on the induction and proof with same reason in this essay and it can be inferred by investment operation underlying based on

separate options, exchange rate, futures, etc as foundation. In addition, in respect of evaluation period and sampling period of Value-at-Risk, they can also be adjusted based on practical requirement. If it is financial institution like bank then it can be based on the suggested number of days and thresholds of standard of Basel Capital Accord in 1988 and other plans in Capital Adequacy Directive, CAD, BIS of Europe in 1996. Then based on these related parameters can be set. If it is the periodical rights department of securities merchants, new financial products department or derivative department or assets allocation management institutions, etc, then it can refer the standard setting suggestion from the G30 meeting of International Derivative Financial Products. As starting from 1997, countries in G10 already adopted the above-mentioned plan, therefore the implementation of assets allocation insurance strategy based on that standard will be able to conform to international trend and standard.

## References

- [1] Zue, Y. & Kavee, R.C., "Performance of Portfolio Insurance Strategies," *Journal of Portfolio Management*, 1988, 48-54.
- [2] Black & Jones, "Constant-Proportion Portfolio Insurance," *Journal of Finance*, 1988.
- [3] Estep & kritzman, "Time-Invariant Portfolio Protection," *Journal of Finance*, 1988.
- [4] Rendleman, R. & Brien, T., "The Effect of Volatility, Misestimation", 1990.
- [5] Merton, R.C., "Theory of Rational Option Pricing," *Journal of Economics and Management Science*, 1973, (4), 141-183.
- [6] Leland, H.E., "Option Pricing and Replication with Transaction Costs," *Journal of Finance*, (40), 1985, 1283-1301.
- [7] Leland, H.E., "Who Should buy Portfolio Insurance?," *The Journal of Finance*, 1980, 581-597.
- [8] Bookstaber, R. & Langsam, J.A., "Portfolio Insurance Trading Rules," *Journal of Future Market*, 1988, 15-31.
- [9] Duffie, D. & Dan, J., "An Overview of Value-at-Risk," *Journal of Derivatives*, 1997, 7-48.
- [10] Longerstaly, J. and More, L.. *Introduction to RiskMetrics™*. 4<sup>th</sup> Edition, Morgan Guaranty Trust Company: New York, 1995.
- [11] J.P. Morgan: *Technical Report*. 4<sup>th</sup> Edition, Morgan Guaranty Trust Company: New York, 1996.
- [12] Engle, R.F., "Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of United Kingdom Inflation," *Econometrica*, 1982, (50), 987-1007.
- [13] Bollerslev, T., "Generalized Autoregressive Conditional Heteroskedasticity," *Journal of Econometrics*, 1986, (52), 5-59.
- [14] Bollerslev, T., Engle, R.F. & Nelson, D.B., "Arch Model in Handbook of Econometrics IV," eds Engle, R.F. and McFadden, D.C. Amsterdam: Elsier Science, 1994, 2959-3038.

# Diminishing Signaling Traffic for Authentication in Mobile Communication System

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## Abstract

To identify a mobile station (MS) and validate legal service requests, authentication functions are utilized in the location registration, call origination and call termination procedures. In GSM, the VLR requests the HLR for assistance in authenticating the visiting user. The authentication center (AuC) in the home network generates 3-tuples and sends them back to the VLR for subsequent authentications during the user's residence. If these 3-tuples are used up before the MS's leaving, another request is issued by the VLR. The request is expensive, because it needs to access the HLR/AuC. Traditionally, a fixed-K strategy is used. That is, K 3-tuples are sent to the VLR for each request. Larger K is preferred to reduce the number of the expensive requests for 3-tuples. However, much waste of 3-tuples is observed, especially when an inactive user is considered. Hence, K value should be determined based on the usage pattern of the user. We propose a dynamic-K (DK) strategy to reduce the waste and diminish the signaling traffic for authentication. Simulation results show that the DK strategy can effectively determine the appropriate K value. Not only the waste but also the number of requests are diminished efficiently.

## 1. Introduction

In Global System for Mobile (GSM) communications, the Mobile Station (MS) communicates with the Base Station (BS) by radio. BS are connected to the Mobile Switching Center (MSC) which communicates with the Public Switched Telephone Network (PSTN). There are two kinds of mobility databases for handling service provision. One is the Home Location Register (HLR), and the other is the Visitor Location Register (VLR). The HLR contains the information of all subscribers. The VLR stores the roaming users' records that are used to handle the location update, call origination and call termination [1]. The Authentication Center (AuC) generates security parameters upon the request from the HLR. The AuC may be co-located with the HLR. A simplified system architecture is shown as Fig. 1.

One of the core security issues in personal communication system is user authentication for providing the con-

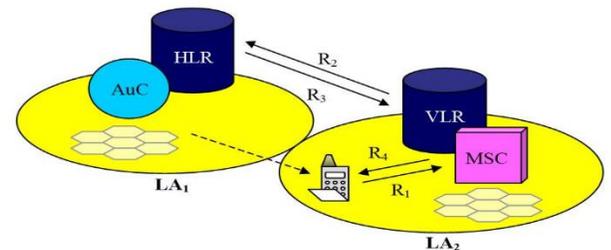


Figure 1: A simplified GSM architecture

tracted services. Another one is session key agreement for securing subsequent sessions. Both of the security issues are accomplished by the 3-tuples (RAND, SRES,  $K_c$ ) generated from AuC. When a roaming user arrives in a location area (LA), the VLR of the LA will need the assistance of the HLR to authenticate the roamer. In general, the HLR asks AuC to generate K 3-tuples and forwards them to the VLR for the subsequent utilization. Each of the location update, call origination and call termination needs one 3-tuple for authentication operation. If the 3-tuples are used up, the VLR will request again and the HLR offers K new 3-tuples. Such arrangement is called fixed-K strategy. The 3-tuples request is expensive, because it needs to access the HLR/AuC. Hence, an larger K is preferred to reduced the number of requests. A very similar mechanism is adopted by Universal Mobile Telecommunication (UMT) which is the third generation mobile service technology evolved from General Packet Radio Service (GPRS). In 3GPP TS 29.002, K=5 is recommended [2].

The 3-tuples transmissions from AuC to VLR may occupy much network bandwidth if larger K is used. Moreover, many 3-tuples are not used before he/she leaves the LA or becomes the victim user. These unused 3-tuples are discarded and becomes a waste. The victim user is the one whose VLR record is replaced due to VLR overflow [3]. The 3-tuples in the record will be lost under such condition. Especially, the inactive users are the more possible targets to be selected as a victim [4]. Because they seldom make/receive calls, the waste of 3-tuples is more serious.

Thus, it is desirable to select an appropriate K value to reduce the waste and minimize the signaling traffic for authentication. In this paper, a dynamic-K strategy is inves-

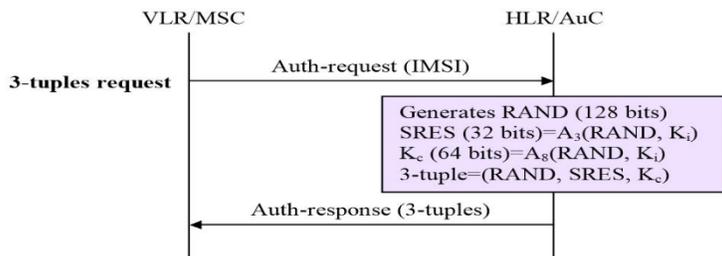


Figure 2: The 3-tuples request protocol between VLR and HLR/AuC

tigated. The authentication protocol in GSM is described in section II. Section II also explains the relationship between the waste of 3-tuples and the VLR overflow. The dynamic-K strategy is introduced in section III. According to various system parameters, the numerical analysis is investigated in section IV.

## 2. User Authentication and VLR Overflow

When a roaming user visits an LA, the service is provided by the system in the visited area. The visited system should verify the identity of the user to provide the contracted services. The verification is implemented with an authentication protocol between the MS and the VLR/MSC. For simplicity, we assume VLR is co-located with the MSC. For the security of the user, the authentication must be executed under the assistant of the user's HLR. The VLR cannot authenticates the roaming user itself. The details of the authentication is introduced in this section. Moreover, the VLR overflow control scheme may affect the authentication information. The affection is also described briefly in the subsection.

### 2.1 The Authentication Protocol in GSM

In GSM, each SIM card has a unique International Mobile Subscriber Identity (IMSI) and a secret key ( $K_i$ ). One-way functions  $A_3$  and  $A_8$  are used during the authentication. Fig. 2 diagrams the 3-tuples request protocol which is executed as the roaming user arrives in the LA or the 3-tuples are used up. The aim of the request is to gain  $K$  3-tuples computed by the HLR/AuC of the roaming user. The first 3-tuple is for the location registration that confirms the arriving of the user. Whenever he/she wants to take advantage of system services (call origination or termination), the remaining 3-tuples will be used for the authentication of the roaming user. One authentication for services needs one tuple.

Fig. 3 shows the authentication protocol between MS and VLR/MSC. To verify the identity of the roaming user, the VLR/MSC sends RAND to the user. RAND is a 128-bits random number. The roamer uses its secret key  $K_i$ , RAND, and  $A_3$  algorithm to compute SRES\* which is sent back to the VLR. If the stored SRES matches the received SRES\*, the authentication is successful and services will

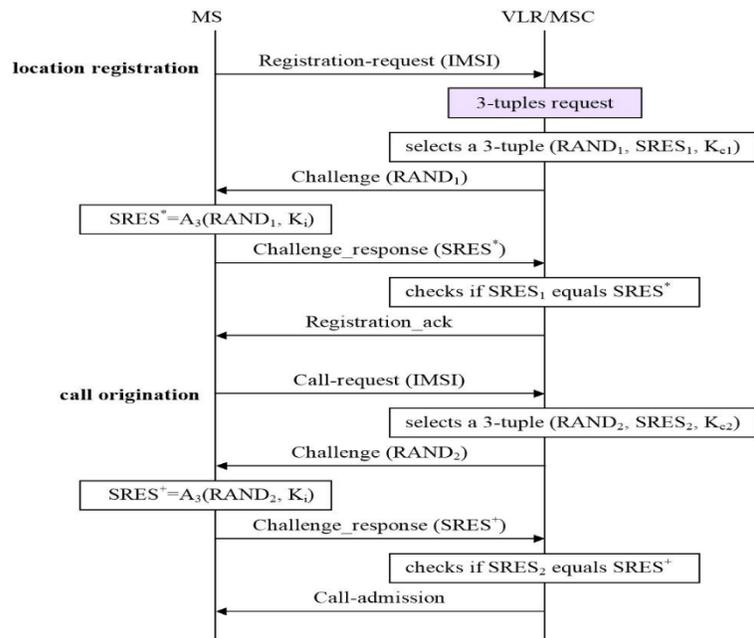


Figure 3: The authentication protocol between MS and VLR/MSC

be provided to the roaming user. Besides, the MS uses  $K_i$ , RAND, and  $A_8$  algorithm to compute the session key  $K_c$ . The  $K_c$  is utilized for encrypting/decrypting the subsequent session between MS and MSC.

### 2.2 The Waste of 3-tuples in VLR Overflow

When a mobile user roams from his/her home system to another system, a temporary record for the user is created in the VLR of the visited system. The record includes information for handling calls to or from the user. In order to generate the important VLR record, the roamer must inform the VLR about his coming by registration. When the user leaves the visited system, deregistration is necessary to cancel the corresponding record in the VLR [5]. The number of VLR records changes dynamically when the visitor moves in or out. Due to the limited capacity, the VLR may become full if too many mobile users enter a VLR during a short period. As a VLR is full, the arriving mobile users will fail to register in the VLR. In such condition, these users cannot receive any service. The phenomenon is called *VLR overflow*. These users are called *overflow users*.

To resolve the VLR overflow problem, an overflow control scheme selects a record from the overflow VLR as a victim. The victim will be replaced with the record of the overflow user. The approach enables overflow users to receive services even when a VLR overflows. The inactive users are the mobile subscribers with low probability to issue/receive calls. Hence, the inactive users are the better targets to be selected as victims. [3]

The 3-tuples are stored in the VLR record. Once the

record is replaced, the remaining 3-tuples will be lost. When the victim user would like to make/receive calls, his/her record must be reconstructed again. Another 3-tuples request is issued from VLR to HLR for  $K$  new 3-tuples. Even if the record of an inactive user is never replaced, the remaining 3-tuples are still discarded when he/she leaves the LA. The waste of the 3-tuples is considerable for the inactive users. In next section, we propose a dynamic-K strategy to diminish the waste of 3-tuples and the authentication traffic load in signaling network.

### 3. The Dynamic-K Strategy

The main idea of the dynamic-K (DK) strategy is that the number of 3-tuples should be determined according to the call frequency of the roaming user. A user with high call frequency should be given more 3-tuples. On the other hand, less 3-tuples are enough for the inactive user. In this method, a simple call counter is maintained in the VLR record of the user. When a call origination/termination occurs, the call counter  $cn$  increases by one. If the user has no call for a period of time, the call counter  $cn$  decreases by one. As a roaming user arrives an LA, the registration procedure enables the VLR to request 3-tuples from the HLR/AuC of the user. Because no historic analysis of the user's call activity, three 3-tuples are generated and transferred to the VLR. If the user is an active user, the three 3-tuples will be used up soon. Then,  $K$  is computed with  $K = cn + m$ , where  $m$  is the system parameter preset by the system manager. The next request for 3-tuples will be responded with  $K$  3-tuples. To compare the DK strategy and fixed-K strategy, we designed simulation models for both of them. For approximating true condition, the overflow control scheme with second chance replacement policy is also added in our simulation models [3]. We made the following assumptions in our experiments [6, 7].

- There are two classes of mobile users. Class 1 users have a low call connection rate  $\lambda_{c,1}$ , and class 2 users have a high call connection rate  $\lambda_{c,2}$ .
- The user arrival rates of the class 1 and class 2 users are  $\lambda_{u,1}$  and  $\lambda_{u,2}$ , respectively.
- The call connections are Poisson processes [8].
- The user arrivals are assumed to be Poisson processes, too.
- The residence time distributions of all users have the Gamma distribution with mean  $1/\lambda_m$  and variance  $V_m$  [9].

The second and third assumptions can be easily relaxed to fit general distributions in our simulation experiments. For the stable simulation result, 1,000,000 roaming users are simulated in each simulation run [10]. The output of the simulations are the number of waste 3-tuples  $N_w$  and the number of the request for 3-tuples  $N_r$ . The analysis of the DK strategy and the fixed-K strategy is investigated according the simulation results.

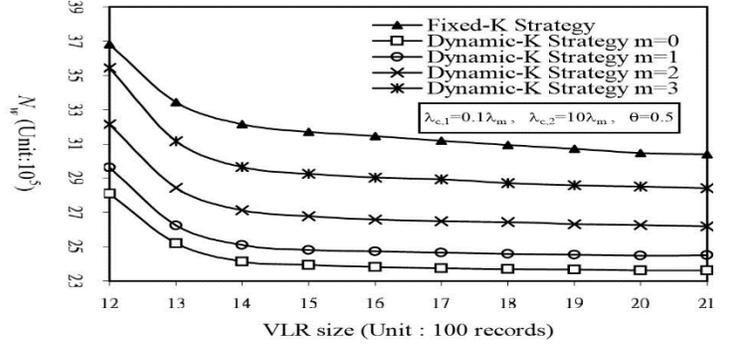


Figure 4: Effects of  $V$  on  $N_w$

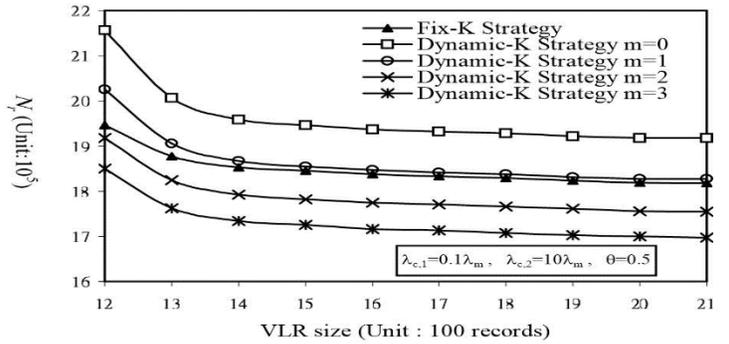


Figure 5: Effects of  $V$  on  $N_r$

### 4. Numerical Analysis

As mentioned above, the VLR residence time distributions for both classes of users are assumed to have the Gamma distribution with mean  $1/\lambda_m$  and variance  $V_m$ . In our simulation,  $V_m = 1/\lambda_m^2$ ,  $\lambda_{c,1} = 0.1\lambda_m$  and  $\lambda_{c,2} = 10\lambda_m$  are considered. We also assume that the total user arrival rate  $\lambda_u$  to a VLR area is a fixed value  $2000\lambda_m$ , where  $\lambda_u = \lambda_{u,1} + \lambda_{u,2}$ .  $V$  represents the VLR size.

Fig. 4 plots  $N_w$  as functions of VLR size  $V$ . In this experiment, we assume that  $\theta = 0.5$ , where  $\theta = \frac{\lambda_{u,1}}{\lambda_{u,1} + \lambda_{u,2}}$ . That is, half of the roaming users are class 1 and the other half are class 2. Compared with the fixed-K strategy, this figure demonstrates that the DK strategy can always reduce the waste of the 3-tuples. As VLR size increases, the waste decreases for both DK strategy and fixed-K strategy. Due to the larger VLR size, the frequency of discarding the 3-tuples drops off with the probability of record replacement. Another interesting phenomenon is that greater system parameter  $m$  seems to reduce the performance of the DK strategy. A straightforward judgment is that  $m = 0$  is the best choice. However, the answer will be quite different when the number of 3-tuple requests  $N_r$  is considered below.

The relationship between  $N_r$  and VLR size is illustrated in Fig. 5. For the same reason in previous discussion,  $N_r$  decreases as VLR size increases. Moreover, another im-

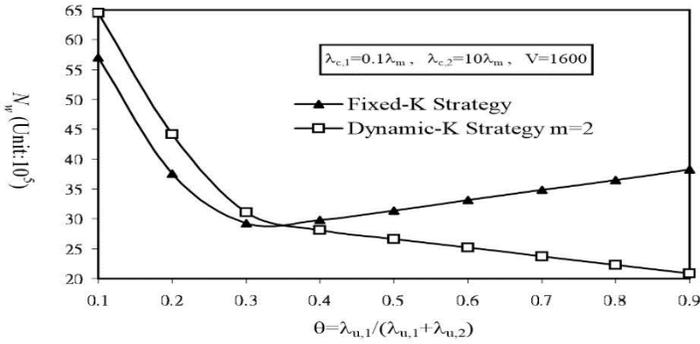


Figure 6: Effects of  $\theta$  on  $N_w$

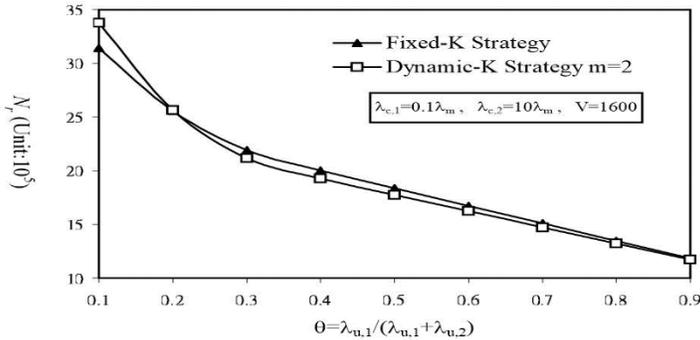


Figure 7: Effects of  $\theta$  on  $N_r$

important phenomenon is noticed. When  $m$  is greater than 1, the DK strategy needs less  $N_r$  than the fixed-K strategy. The request for 3-tuples is expensive, because it needs to access the HLR/AuC. Therefore, any strategy to reduce the waste of the 3-tuples should not increase  $N_r$ . From Fig. 4 and Fig. 5, we know that  $n=2$  is a good choice for DK strategy which can diminish both  $N_w$  and  $N_r$ .

The effects of  $\lambda_{u,1}$  and  $\lambda_{u,2}$  are shown in Fig. 6. It plots  $N_w$  as functions of the ratio  $\theta$ . As  $\theta$  increases, the class 1 users increases. It means that the average number of the calls per user decreases. A significant phenomenon is that the waste caused by fixed-K strategy increases for  $\theta > 0.3$ . Obviously, it is inefficient to set  $K=5$  fixedly. A contrasting result gained by the DK strategy. The waste always decreases as  $\theta$  increases. For  $\theta > 0.35$ , the DK strategy outperforms the fixed-K strategy. If  $\theta < 0.35$ , most of the user are active and their  $K$  value will be increased by DK strategy. Once they leaves, the average of waste is  $K/2$  which has high probability to be larger than  $5/2$ . Under such condition, the system manager can adjust  $m=1$  or  $0$  to get better performance than fixed-K strategy.

The relationship between  $N_r$  and  $\theta$  is illustrated in Fig. 7.  $\theta < 0.1$  is the extreme case. Under such condition, almost all users have high probability to make/receive calls. The  $N_r$  becomes very high. In other words, most users need to make more than one request for 3-tuples. Because three 3-tuples are given for the first request in the DK strategy, it has higher probability to require the second re-

quest than the fixed-K strategy which gives five 3-tuples. However, this is an abnormal condition and seldom happens. For  $\theta > 0.2$ , the DK strategy always needs fewer 3-tuples requests than the fixed-K strategy.

## 5. Conclusion

The 3-tuples (RAND, SRES,  $K_c$ ) are generated from the HLR/AuC, which enable the VLR to authenticate the roaming user. A similar protocol is adopted by the third generation mobile service technology. The fixed-K strategy is used in GSM and 3G communication systems. Since the cost for accessing HLR/AuC is expensive,  $K=5$  is recommended for the fixed-K strategy to prevent too many requests for the 3-tuples. It means that five 3-tuples are sent back to the VLR from HLR/AuC for each request. However, this strategy is inflexible. Much waste of the 3-tuples is observed. In this paper, we propose a dynamic-K (DK) strategy to diminish the waste. Most importantly, the DK strategy can reduce the number of the expensive requests for 3-tuples at the same time.

The main idea of the DK strategy is that  $K$  should be adjusted dynamically based on the call pattern of each user. The active user makes/receives calls often, so higher  $K$  is appropriate for them. On the other hand, the inactive user needs only smaller  $K$  value to prevent the waste of 3-tuples. The DK strategy can provide appropriate  $K$  value for each user. Simulation results show that the DK strategy gains better performance than the fixed-K strategy in most scenarios investigated in our study. The DK strategy reduces not only the waste of 3-tuples but also the number of the expensive requests for 3-tuples. Furthermore, a parameter  $m$  is provided to the system manager for adjusting the tradeoff between the waste of 3-tuples and the number of requests according to various population of resident users. The DK strategy is efficient and flexible to diminish the signaling traffic for authentication in GSM and 3G mobile communication systems.

## References

- [1] I. Chlamtac, T. Liu, and J. Carruthers, "Location Management for Efficient Bandwidth Allocation and Call Admission Control," *Proc IEEE Wireless Commu. and Networking Conf.*, Sept. 1999..
- [2] 3GPP, "3rd Generation Partnership Project; Technical Specification Core Network; Mobile Application Part specification for Release 1999," Technical Spec. 3G TS 29.002 version 3.7.0 (2000-12), 3GPP, 2000.
- [3] C.-C. Lo and K.-L. Sue, "Second Chance Replacement Policy for Mobile Database Overflow," To be appeared in *Proc. IEEE GLOBECOM'02*.
- [4] Y.-B. Lin, "Overflow control for cellular mobility database," *IEEE Trans. Veh. Technol.*, vol. 49, no. 2, pp. 520-530, Mar. 2000.
- [5] I. F. Akyildiz, J. Menair, J. S. M. Ho, H. Uzunalioglu, and W. Wang, "Mobility management in Next-Generation

Wireless Systems,” *Proc. IEEE*, vol. 87, pp. 1347-1384, Aug. 1999.

- [6] Y. Fang and I. Chlamtac, “Teletraffic Analysis and Mobility Modeling for PCS Networks,” *IEEE Trans. on Commu.*, vol. 47, no. 7, pp. 1062-1072, Jul. 1999.
- [7] Y.-B. Lin, “Modeling techniques for large-scale PCS networks,” *IEEE Trans. on Comput.*, vol. 50, no. 4, pp. 356-370, Apr. 2001.
- [8] S.M. Ross, “Stochastic Processes Volume I-Theory,” John Wiley & Sons, Inc., 1983.
- [9] S.M. Ross, “Introduction to Probability Models,” Academic Press, Inc., 1993.
- [10] J. Banks, J. Carson II, and B. Nelson, “Discrete-Event System Simulation,” Prentice Hall, 1996.

# A Model Architecture to Combat Security Issues in Mobile Commerce

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## Abstract

The security of transactions in mobile commerce is moving away from being just an IT concern to being a business concern because of the potential loss of revenue to businesses due to lack of privacy, integrity or confidentiality, system slowdown or downtime. While most security procedures are limited to corporate IT infrastructure, in mobile commerce, issues concerned with transaction security appear to have extended beyond the corporate network to embrace the complete business process. Any lapse in procedures that maintain the confidentiality of data or the violation of privacy could affect corporate image and hence would impact on customer relationships. In turn, any adverse effect on customer relationships would impact negatively on business revenue. In addition to existing security problems in a wired commerce environment, the emergence of mobile devices has renewed calls for addressing security threats to financial transactions. These problems are discussed in this paper as key issues in terms of an organization's architectural and procedural approaches to the security, reliability and availability of business transactions.

**Keywords:** Mobile commerce, security threats, IT security, risks, business transactions.

## 1. Introduction

In the past, the majority of the computer security officers have had difficulty in convincing management to allocate financial resources for IT security. However, with the emergence of electronic commerce and various legislations, organizations appear to have understood the necessity for computer security, especially data security [5]. The current trend in most organizations, therefore, appears to be one of security officers focussing on IT security – namely – hardware security, software security and access security [5]. Access security involves both physical access and logical access. What appears to be missing from these security procedures is the proper integration of business transactions. Ghosh [11] states that

while various security measures have dealt independently with business transactions, electronic commerce and the emerging mobile commerce have changed the perception that an independent IT infrastructure security alone can protect an organization in terms of its business needs. To support Ghosh's statement, Deise et. al. [7] has identified the shift in the focus of IT security in organizations, resulting in new security policies to focus on reliable, available and trusted business transactions.

Initially in this paper, the new security threats arising from mobile commerce are highlighted. These threats are then linked to financial transactions in order to highlight the potential loss or damage to an organization's revenue. The organizational IT requirements are assessed with a view to providing support for financial transactions in a mobile commerce environment. This organizational support is then formed into an 'architecture' and the architecture is discussed in terms of how it supports an organization and what it does to support financial transactions in particular. This architecture is subsequently elaborated in terms of a series of action items so that transaction security in an organization can be guaranteed. It is hoped that these action items would then enable organizations to tighten their current security strategies.

## 2. Security Threats Arising from Mobile Commerce

Security threats in mobile commerce can range from the passive eavesdropping of messages to actively stealing data [19]. In a radio frequency operated mobile commerce environment, it is possible to listen to conversations with minimum difficulty. This has an impact on consumers causing concern about their data and about voice messages from unauthorized access. At the other end of the problem is the inherent security risk involved in transferring information over networks. This problem consists of two components: *identification integrity*, and *message integrity*. Identification integrity refers to the signature elements found in the messages which establish where the

message originates. Message integrity refers to details to establish that the message is received as sent and that no third party has attempted to open, modify or alter the contents. According to Zhang & Lee [25], these two items appear to cause a lot of concern to both senders and receivers. While the senders risk the theft or misuse of their personnel information such as account and bank details, the receivers (usually a merchant) risk repudiation of the transactions and the resultant non-payment.

Further security concerns in mobile commerce arise from the development in the technology itself [25]. It is envisaged that mobile technology will be offered with payment for the range of services offered. This is already emerging in the domain of mobile telephones. For instance, when a mobile telephone user accesses other network carriers, a special charge is levied on the user. Therefore, it is safe to assume that there will not be any "free services" in the future. The technology is developing in such a way that the payment for such services will be through some form of "smart card". The details stored in the smart card will need to be transmitted via the networks for validation and verification in order to determine service levels. If these networks are not fully secure, security breaches may occur.

One major security breach that can happen in mobile commerce is when user details are transformed from one mobile network to another [13]. When this transformation occurs, any encrypted data needs to be decrypted for transparency. In mobile commerce, when mobile devices make requests to the web pages of a network server, a four-stage process is followed. First, the requests arise from the originating Wireless Transport Security Layer (WTSL) protocol. Second, the requests are translated at the originating Wireless Application Protocol (WAP) gateway. Third, they are sent to the standard Session Security Layer (SSL) protocol of the destination network. Fourth, the translated information reaches the Hyper Text Transfer Protocol (HTTP) modules in the new network in order for the requests to be processed. In the course of translating one protocol to another, the data is decrypted and then re-encrypted. This process is commonly known as the "WAP Gap". If an attacker is able to have access to the mobile network at this point, then simply capturing the data when it is decrypted can compromise the security of the session.

Data in the Mobile Commerce environment is secured using encryption technology. According to Ghosh [11], it has already been proven that this technology is vulnerable to attack. Hackers have broken some of the existing algorithms for encryption, so there is nothing like complete security. Further, there is no international regulatory framework available to enforce certain security related problems. For example, in the current climate, no individual organization or government can guarantee security to consumers. When a security breach appears in an international transaction, no one country will be able to assume responsibility to prosecute the perpetrators. While these problems have been recognised and solutions are being proposed, organizations are losing consumer

confidence. This has the potential to impact the revenue generated by these organizations.

Trust is central to any commercial transaction and more so in the case of mobile commerce [9]. Trust is normally generated through relationships between transacting parties, familiarity with procedures, or the redress of mechanisms. In the case of mobile commerce, the need for creating the trust in the consumer assumes extreme importance because of its virtual nature. It hinges on assuring consumers and businesses that their use of network services is secure and reliable, that their transactions are safe, that they will be able to verify important information about transactions and transacting parties such as origin, receipt and integrity of information, as well as the identification of parties dealt with. Therefore, the challenge is not to make mobile commerce foolproof, but to make the system reliable enough so that the value greatly exceeds the risk.

Any new development in technology in today's consumer mind creates both curiosity and reluctance. The informality and lack of overall control creates the perception that the Internet is inherently insecure [20]. This perception can trigger business and technological risks [21]. Business risks involve products and services, inadequate legal provisions, the reliability of trading partners, the behaviour of staff and the possible demise of the Internet service provider. Technological risks involve hacker attacks, computer viruses and data interception. To achieve satisfactory levels of trust, organisations have to think about managing both business and technological risks. Currently mobile commerce relies mostly on knowledge-based trust that is useful for Business-to-Business commerce [9]. However, there is a big surge in identification-based trust to satisfy consumers' concerns about their transaction details. In addition, the current architecture for mobile communications does not provide full security in terms of transaction integrity. Some of the models envisaged for mobile commerce are based on a smart card approach and hence the issue of financial transaction security needs greater examination.

### **3. Security Threats that Can Impact Financial Transactions**

Security risks in a mobile commerce environment associated with financial transactions can be categorised into traditional risks and non-traditional risks [14]. Traditional risks usually involve loss or damage to tangible physical assets and resulting economic loss. For example, loss of computer hardware may have an impact on incomplete transactions. Alternatively, a missing data disk, which is not fully protected from theft can place an organisation at risk. Treatment of traditional risks is usually addressed in risk management policies. Protecting tangible assets from traditional perils, even when those assets are devoted to mobile commerce, does not involve new and different techniques. These security treats are beyond the scope of this paper.

Non-traditional risks involve damage to organisations'

computer systems and electronic data [24]. These risks include stolen information, damage to web sites by hackers, the hijacking of web sites and viruses. An attack may be perpetrated for any number of reasons including financial gain involving credit card fraud, curiosity with no specific intent of harm, espionage by domestic or foreign competitors, or foreign governments, revenge by a terminated employee who is intent on wiping out files, disclosure of personal data to unauthorised institutions as in health related cases, thrill seeking, disruption to stop critical activities, and extortion for financial or political reasons. Any attack, internal or external, on a computer system is disruptive and forces the administrator to shut down the system resulting in revenue loss.

Non-traditional security breaches also include unauthorized access or the use of a company's computer system and data by an outsider or an insider [7]. For example, a hacker could break into a company's computer system and steal or destroy data. Widespread use of mobile commerce enhances the possibility of an outsider invading an organisation's computer system. Due to the reliance on computers for daily operations, breaches of a company's computer or information security system are a risk to almost all functional components of the business. Use of software to encrypt and, thus, safeguard communications provides some protection, but also adds the risk that a virus or other bug could damage the equipment or data. Further, according to Dang [6], theft of information such as critical electronic files including financial data, customer information, marketing and new product data, trade secrets, and personnel data may provide competitors with a strategic advantage, criminals with the means to commit fraud, and others the opportunity to disparage the company. Moreover, Dornan [8] states that the use of misappropriated information may harm third parties such as customers, employees, and business partners. The theft of information may undermine an acquisition or cause a public relations problem and hence potential loss of revenue.

Security breaches may be very costly to an organisation [10]. When an unauthorized access to the computer is gained for the purposes of committing a crime such as fraud, reputation is also at stake. Other security issues include the prohibition of high-level encryption technology by domestic or foreign governments so that agencies can break the codes if necessary for defence or law enforcement, changes in international standards, and loss of encryption key recovery.

#### **4. A Closer Look at Fraud and Crime Risks in Mobile Commerce**

The scope of computer fraud and crime is immense in mobile commerce. Among the most common crimes are malicious mischief, such as the insertion of viruses or Trojan horses into one or more computer systems; the fraudulent transfer of money to personal accounts; the use of forged electronic signatures; the theft of credit card information and credit card fraud; Medicare and Medicaid

fraud; the theft of intellectual property; illegal use of software; stock and commodity market manipulations; and similar illegal activities. Most losses are insurable, but premiums will be relatively exorbitant if security measures are not appropriately enacted [13].

A hacker may use a number of methods such as the insertion of viruses, spamming and web snatching to access computer systems and data and to cause damage. Damage may occur at data centers or in the transmission networks, routers, or power sources. Virus attacks may also come from innocent parties who pass on an infection without knowledge that the system is contaminated, usually by e-mail.

By using another technique, *distributed denial of service*, hackers have been able to attack some of the most well-known and highly secure web sites in the world, including Yahoo.com, eBay.com, and amazon.com. This technique hijacks numerous computers on the Internet and instructs each one to flood a target site with phoney data. The target site, trying to accommodate the phoney data, becomes overworked and soon begins to lose memory. The result is effectively slowing or shutting down the entire site to real customers.

*Web snatching* is a practice in which one party plants a virus in another party's Web site that automatically moves the viewer from the selected site to a site run by the web snatcher. This is done without the permission of the selected Web site owner or the site visitor. In many instances, the viewer is unable to get out of the unwanted site, short of turning off the computer, so is effectively held hostage to the new site. The diverted-from and diverted-to sites usually have nothing in common with each other.

Financial institutions and companies that have inadequate electronic security protection are more likely than not to suffer losses of money, information, or other corporate assets. Surveys have shown that most companies and institutions have incurred losses, and a substantial number have no idea whether they have come under electronic attack or not. Insiders or former insiders have committed most of the electronic crime and fraud, but there are many examples of third-party fraud and theft.

Mobile commerce can only be conducted if all parties believe there is adequate security. The majority of those who use the Internet, on which current mobile commerce technologies are built, are very concerned about security [11]. Some 40 percent of Internet consumers give false information when they use the Web because they do not trust the Internet's security [4]. Other users refuse to register at sites that require what the consumer believes to be personal information [1]. Many people want the government to legislate security on the Internet as they are not confident that businesses will do the job on their own [23]. Therefore, it is critical that businesses enhance both their security and their security image to combat crime on the Internet, as well as to increase customer confidence and participation in virtual business environments.

#### **5. Security Risks in Mobile Commerce**

## Emerging from Reliance on Third Parties

Today, most organisations rely on computers for their daily operations. Traditional and non-traditional security risks can interrupt a business or literally shut it down. For example, a security breach by a hacker can severely disrupt a business and those who depend on it. Most businesses in mobile commerce are dependent in several ways on the continued reliability and operation of computer controlled systems not within their control, such as the telephone network which is managed and controlled by computers. Businesses are dependent on their financial institutions that are also managed and controlled by computers. In mobile commerce, to accommodate home users, organisations are dependent on their Internet Service Providers (ISP). Suppliers and customers depend on each other's electronic data systems and on mutual systems, such as a third-party commodity exchange. When one system fails, it may cause the other systems to fail as well. Failure may be a slowdown in the dependent system, also called the 'brownout' or a total denial of service, also called the 'blackout' [11]

The above risks can result in many different types of losses [2] [8] [22]. Traditionally, property losses have meant damage to a building or other business property, including computer equipment. In the mobile commerce world, however, the focus is on damage to computer networks and, more importantly, to data. An important issue is whether data is considered tangible property under a typical property insurance policy. It appears that insurers are only beginning to address the issue of what is defined as 'covered property' under their policies at it is more likely that, in the long run, the courts will have to decide on this issue.

Property losses can also occur when an organisation's intangible or intellectual property is infringed or violated. Copyrighted materials can be copied without permission, trademarks can be infringed upon or diluted, and patented property or ideas can be stolen. Today, a firm's intellectual property may be its most valuable asset [7]. In mobile commerce, organisations need to be extra vigilant in protecting their intellectual property from hackers, crackers, competitors, and others, as well as make sure they do not infringe the intellectual property rights of third parties. This could potentially expose a firm to third-party liability.

Time losses typically include business interruption (BI) losses and service interruption losses. A BI loss is the economic loss resulting from the interruption of business activities. Business interruption losses may result from the inability to access data, the theft of data, or a threat to the integrity of a database. For example, a breach in the security of a credit card database may cause the database owner to curtail activity on the system until a damage assessment is completed and the system integrity is re-established. Not only is there a disruption of the database operations, there is also a consequential effect on all third-party users of the system.

Service interruption losses include economic losses

associated with the interruption of utilities. A service interruption incident can occur from an "off-site" exposure or event. There have been many incidents of communication cables inadvertently being cut. Long-distance telecommunication companies have experienced software problems in data routing that effectively crippled their networks for several days. According to Lee [17], service denials may cause a customer business interruption, network suspension, or a disruption in or delay of services. Service denials may result in damage claims or lawsuits for breach of a service contract.

Mobile commerce gives rise to new implications for doing business and being protected from interruptions [3]. Businesses suffering losses related to server outages face the risk of losing customers for extended periods of time. In mobile commerce, the increased reliance on suppliers is also exposing businesses to new risks for financial losses. These range from suppliers of goods (such as raw materials) to suppliers of services (such as server usage, delivery services, electricity, and telephones).

Business interruption may have several consequences - e.g., loss of income; extra expenses to recover; loss of customer, partner, and shareholder confidence; and, ultimately, reduced market capitalization. In some cases, business interruption may constitute a breach of contract and third parties harmed by the denial of service may sue, adding liability losses to first-party damages.

## 6. Expense Incurred by Organizations due to Business Interruptions

In the event of an interruption, a business may incur extraordinary expense to resume operations as quickly as possible. An example of extra expense might be increased freight charges to avoid delays in the production process associated with a loss event. In the mobile commerce area, there are new types of costs in the context of risk and insurance, including the costs of operating a web site from an alternative server, the costs of operating a web site through an alternative provider, the costs of repairing web sites damaged by hackers or equipment failures, and the costs of rebuilding other lost information [18]. Thus, various security risks arising from a combination of issues warrant closer scrutiny of the assessment of an organisation's IT requirements in order to facilitate secure financial transactions.

## 7. Assessment of Organization's IT Requirements

In order to guarantee the security of transactions in mobile commerce, the initial assessment of an organisation's IT requirement is essential for a number of reasons [16]. These include ever-changing customer requirements, changing hardware and software platforms, changing user needs and user experiences gained from innovative IT products. Therefore, such an assessment involves the four key components of mobile commerce.

They are (1) embedded computers in many everyday objects [12]; (2) next generation wireless networks [10]; (3) interfacing technologies for bi-directional communications [5]; and (4) design of an application that satisfies user needs [6].

The first key component, embedded computers, arises from the projected increase in wireless devices by 2005 and the prediction that, by 2005, mobile devices will outnumber wired devices [15]. These mobile devices would consist of some form of embedded system and hence the allocation of priority. The next component, wireless networks, follows from the first one which highlights the need for networks to be wireless (to support the concept of mobility and hence mobile devices). Users communicate via a number of different mobile devices and hence bi-directional communication is essential for an organisation to ensure that transactions are reliable and secure. Finally, the fourth component, application design, needs to accommodate diversity of user demands.

When an organisation's IT requirements are being assessed, importance should also be given to 'user experiences'. In the mobile commerce environment, user experiences typically involve cameras, music and other innovative technologies such as positioning systems and hence organisations should find a way to accommodate these ever changing user experiences. Organisations would then be tempted to add additional hardware and software resources to their existing infrastructure to accommodate these innovative technologies but this would increase their financial burden. One emerging suggestion appears to be the consideration of 'interface' facilities to enable the sharing of other third-party resources. This requires address and connectivity mechanisms that do not exist today. While recent newspaper articles forecast that such capabilities are emerging, the challenge for organisations is to create applications that truly have this multi-modal, multi-channel character because it is believed that the immediacy of wireless technology is great.

With this in mind, if we analyse an organisation's IT infrastructure, then we would be able to sort business needs to support secure transactions into four main groups. They are:

1. Technical infrastructure that can identify what IT consists of in an organisation;
2. Physical components of IT that can identify how these components support various workflow requirements in an organisation;
3. Logical components that can identify how IT components support various business processes; and
4. Real time measurement and control of security and service levels in real time.

While the first three points provide essential components of an application architecture in an organisation, the fourth provides the control and maintenance components of the application architecture. Real time control is essential in mobile commerce because

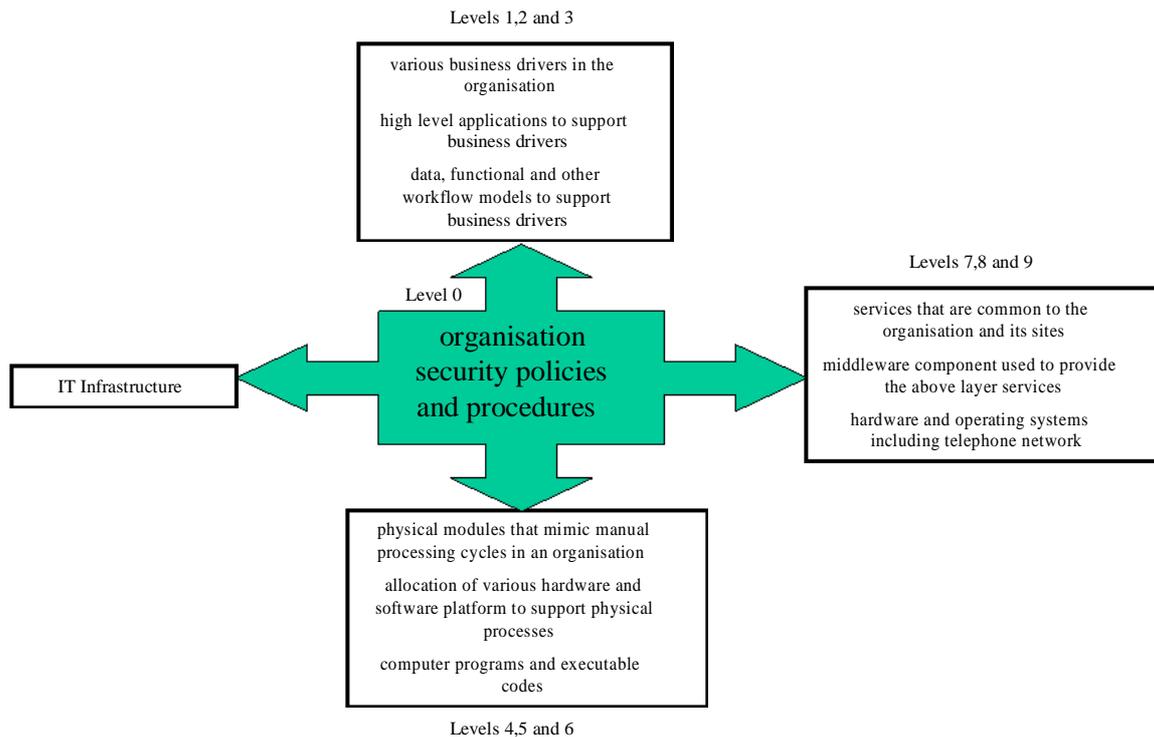
of the difficulty in describing complete security architecture to ensure security of transactions.

## 8. The Architecture

The architecture, shown in Figure 1, consists of 10 levels, starting from level 0. The level 0 is where all security policies that ensure transaction security are dealt with. This is a management component and independent of the organisation's IT infrastructure. This is because in the mobile commerce environment, due to changing user needs, it is difficult for the security officer alone to ensure the reliability of transactions. It is essential that management assumes the overall responsibility with security officers providing the necessary infrastructure because it is the managers who know the various processes involved in conducting financial transactions. This view is quite different from the current electronic commerce environment where security officers are responsible for data and information security. While this may be possible in a wired environment, due to importance given to the information and its origin in a mobile commerce environment, the view is totally different. Organisations will need to align their business processes with proper security policies because it will be difficult to track users in a mobile commerce environment due to the possibility of 'roaming'.

Further, in mobile commerce environment, users, systems and transactions change rapidly and unpredictably. This requires organisations to accommodate these needs and yet provide reliable and secure transactions. The current static authentication and authorisation process will be superseded in mobile commerce and the new dynamic privilege management will be an essential component. Therefore, risk management associated with an organisation's IT security will also need to be dynamic and to operate in real time to react to incidents and threats more pro-actively. In essence, level 0 of the architecture will ensure that customers, business partners, and other stakeholders of a transaction such as banks and governments interact directly with these business applications and their IT environments, especially in mobile environments. Level 0 architecture will ensure that the transaction environment is up and running, reliable and secure.

The levels 1-3 put the customer first and are specific to business needs. At these levels, several independent business activities are integrated through IT applications to ensure that the data, functions and workflow modules of an organisation are synchronised. Due to increasing demand from customers for mobile commerce, visibility and interaction across the supply chain to the customer are essential. Therefore, manual sub-transactions, usually found in a traditional transaction model (including weaker electronic commerce models), need to disappear and levels



**Figure 1 The Architecture**

1-3 will ensure that this happens. Levels 4-6 consist of the various physical modules to support the workflow. These levels also consist of the 'code' needed to support workflow and the integration of workflow. These levels are of extreme importance to businesses because these are where the integration of multiple segments of a business such as CRM and SCM takes place. Further, due to the physical nature of IT components, this is where the existing resources are integrated with new resources. To establish financial security, levels 4-6 need to be maintained properly because the transaction is split into multiple components at these levels before it is processed. Further, when the transaction is split into component sub-transactions, each of the sub-transaction may run on varied systems with different infrastructures. Organisations, therefore, should focus their 'security' on these levels for successful mobile-commerce. The last three levels are comprised of IT components in order to realise the various combinations of business needs. At these levels, IT components such as a computer are added to the existing infrastructure. While the previous levels 4-6 facilitate business needs, levels 7-9 actually implement them. Issues such as network speed and transaction completion time are essential characteristics at these levels. While the business performance is measured at the previous levels, response time measurement is controlled in the last three levels (7-9). These three levels are vulnerable to attack and the implementation of security procedures starts at these levels.

## 9. Discussion

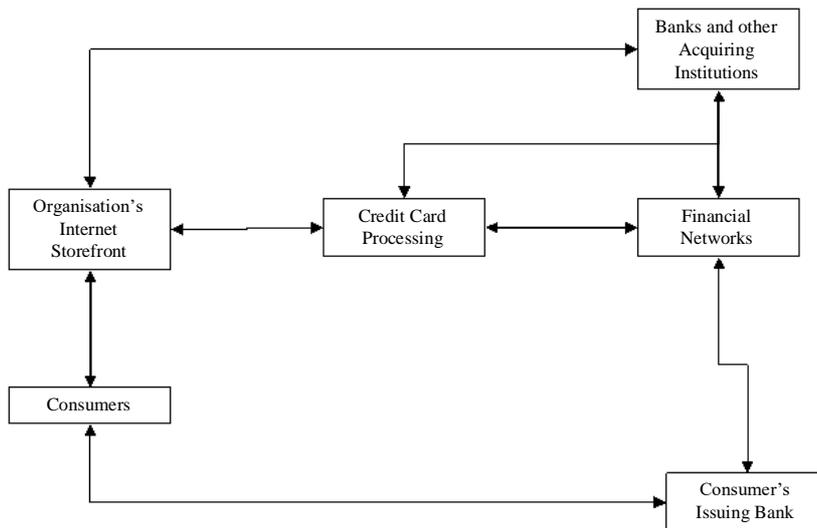
When a financial transaction is facilitated in a mobile

commerce environment, the consumer usually accesses the organisation's computer to search for appropriate details. Once the consumer is satisfied with his/her order, an order is placed. The consumer places an order using the infrastructure provided by the Internet storefront and using his or her payment method of choice. Once the order reaches the organisation, the transaction is processed. A number of security issues, such as, verifying the credentials of the consumer arise at this point. Provision for real-time security and connectivity to authorise payment via the Internet or wireless medium forms an integral component of the transaction. The organisation channels the transaction through various financial networks such as banks, ensuring that customers are authorized to make their purchase.

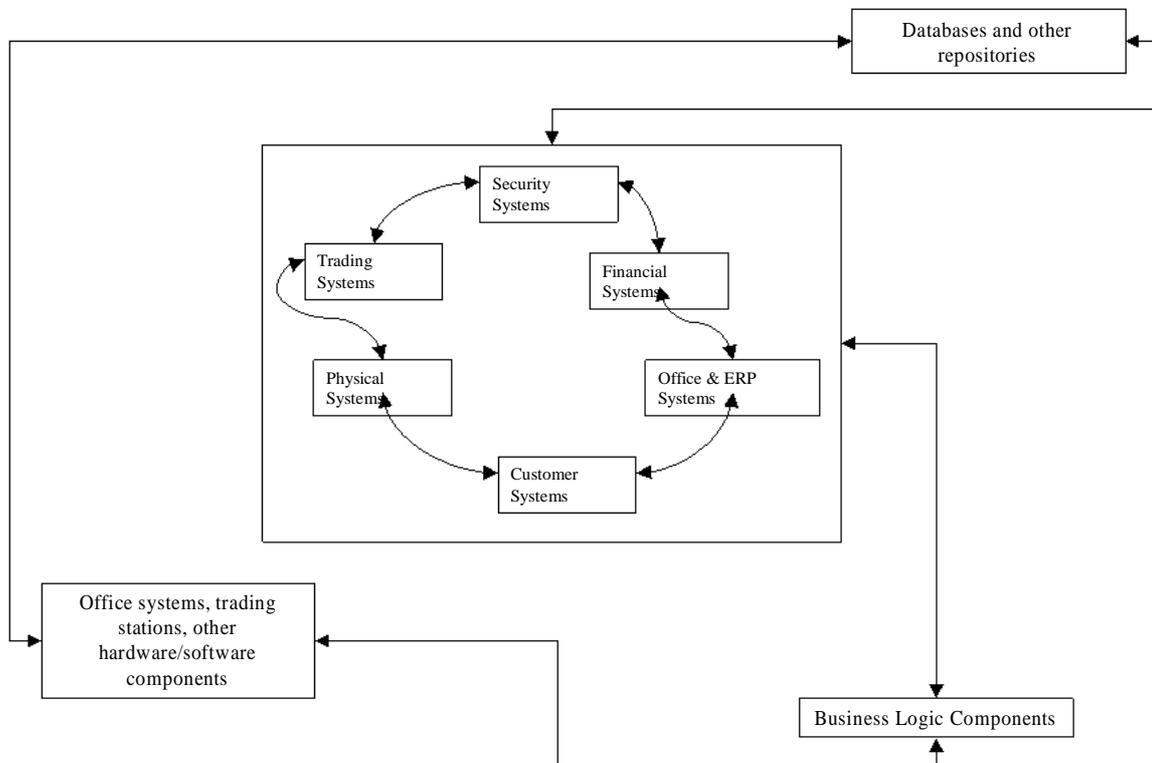
When security issues are applied to a transaction, the client/server architecture for transaction processing is usually used. The client is installed on the organisation's merchant site by the third-party providing user authentication for financial details and this client is integrated with mobile commerce application. The client is usually pre-integrated with store management systems including those for management reporting purposes.

For the purposes of transaction authorization, the client software establishes a secure link with the processing server over the Internet using an SSL connection, and transmits the encrypted transaction request. The server, which is a multi-threaded processing environment, receives the request and transmits it over a private network to the appropriate financial processing network.

Depending upon the consumer's financial status, the transaction is approved or denied. When the authorization response is received from the financial network, the response is returned via the same session to the client on



**Figure 2 Transaction Processing Cycle**



**Figure 3 Business Processing Facilitating Mobile Commerce Transaction**

the consumer's site. The client completes the transaction session by transparently sending a transaction receipt acknowledgment to the server before disconnecting the session.

The whole transaction is accomplished in few seconds, including confirmation back to the customer and the organisation. If the transaction is approved, funds will be transferred to the organisation's account. Once the transaction is confirmed, the transaction will be securely routed and processed. As proof of a securely processed transaction, both the customer and the organisation will

receive a transaction confirmation number. This is shown in Figure 2.

The architecture described in this paper supports almost all the elements of the transaction that can be conducted in the organisation. The security aspects not only involve the organisational IT infrastructure but also third-party security levels in order to approve a financial transaction. It should be remembered that consumers expect the organisation to facilitate a reliable and secure transaction and it is in the interests of the organisation that third parties involved in the transaction are reliable and capable of providing the necessary security for the consumer's

transactional details.

While the above diagram (Figure 2) portrays a complete financial transaction system, the subsystem in Figure 3 portrays the component that needs to be supported by an organisation. Components such as office systems, etc., form levels 7-9 in the architecture outlined in this paper. Components such as databases, etc., would form levels 4-6 in the architecture described above. Other components such as Business Logic Components form levels 1-3 in the architecture. The business processing for the facilitation of a transaction is also highlighted.

## 10. Conclusion

The architecture presented in this paper is an attempt to address various new security concerns in the emerging mobile commerce environment. The architecture has been constructed to accommodate various business processes as an integral component and security management system encompassing these business processes. It is believed that this architecture will assist in avoiding issues such as loss of transaction authenticity because the business process is integrated into the security procedures in the architecture. Further, the business processes are kept in the centre of the architecture to enable transaction confidentiality and integrity from an organisational point of view. Further, the interdependence of various systems within the architecture is expected to provide much needed real-time reaction to any cause of transaction unavailability in mobile commerce.

While the architecture is only conceptual, the inclusion of business processes along with IT security is expected to provide tighter controls in terms of financial transactions. This is rapidly becoming essential in the competitive world of mobile commerce where the volume of transactions ensures healthy revenue for organisations. Therefore, the architecture has been conceived with a focus on transaction security. It is hoped that this architecture helps organisations to get a head start in reviewing their security procedures and in establishing a better control on financial transactions.

## References

[1] Anonymous. E-Commerce is growing. *The Australian*, 15 August 2000.  
[2] Anonymous. Wireless technology reaches behind the firewall. *Informationweek.com*, June 2000, 30.  
[3] Arena, A. Asian Internet start-ups invest heavily in dot.coms. *Australian communications*, February 2000, 15-18.

[4] Craig, J. & Julta, D. *e-Business Readiness: A Customer Focused Framework*. Boston: Addison Wesley, 2001.  
[5] Dang, A. V. *E-Business raises transaction security concerns* (Research Note): Gartner Advisory, 2000.  
[6] Dang, A. V. *Four action items for E-Business: Transaction Security* (Research Note): Gartner Advisory, 2000.  
[7] Deise, M. V., Nowikow, C., King, P., & Wright, A. *Executive's Guide to e-Business: From Tactics to Strategy*. New York: John Wiley & Sons, Inc., 2000.  
[8] Dornan, R. *The essential guide to wireless communication applications*. Upper Saddle River, NJ: Prentice Hall PTR, 2001.  
[9] Fink, D. Developing trust for Electronic Commerce, in L. Janczewski (Ed.), *Internet and Intranet: Security and Management: Risks and Solutions* (pp. 44-86): Idea Group Publishing, 2000.  
[10] Gerrard, M. *Organising for E-Business: Getting it right* (Commentary): Gartner Advisory, 2000.  
[11] Ghosh, A. K. *Security and Privacy for E-Business*. New York: Wiley, 2001.  
[12] Hayward, S., Dulaney, K., Egan, B., Plummer, D., Deighton, N., & Reynolds, M. *Beyond the Internet: The Supranet* (Commentary): Gartner Advisory, 2000.  
[13] Hulme, G. Services Seek to Bring e-Business to Small Businesses. *Informationweek.com*, August 2000, 21.  
[14] Judge, P. Little guys still say NO to the net. *Business Week*, 1998, 134.  
[15] Koller, L. Banks flirting with wireless billing. *Bank Technology News*, 2000, 13, 25.  
[16] Langley, N. Get moving on m-commerce. *Computer Weekly*, 11 May 2000, 68.  
[17] Lee, A. Small firms must take Internet plunge or risk being sidelined. *The Engineer*, 10, November 2000, 10.  
[18] Lewis, T. Ubinet: The ubiquitous Internet will be wireless. *IEEE Computer*, 32, 1999, 10.  
[19] Loney, M. M-Commerce safety fears. *IT Week*, 3, 2000, 6.  
[20] Schiller, J. *Mobile Communications*. New York: Addison-Wesley, 2000.  
[21] Shroeder, S. Wired for business. *Risk Management* March 1999, 12-22.  
[22] Smith, D., & Andrews, W. *Exploring Instant Messaging*.: Gartner Research and Advisory Services, 2001.  
[23] Stowe, B. Wireless networking looks attractive, but what about the cost of keeping it secure? *Infoworld*, May 2000, 92.  
[24] Young, D. Handicapping M-Commerce: Getting ready for wireless e-commerce. *Wireless Review* August 2000, 24-30.  
[25] Zhang, Y., & Lee, W. *Intrusion detection in wireless ad-hoc networks*. Paper presented at the ACM/IEEE MobiCom, 2000.

# An Analysis of Consuming Behavior Model for Adopting Knowledge Intensive Technological Product: The Case of MDA

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## Abstract

The objective of this research is to analyze the correlation between consumers' adoption of MDA and some of its influential variables, namely innovativeness, procurement types, involvement, the degree of Internet used and the basic characteristics of consumers. This paper provides a new model to explain the influent effects between consumers' adoption of MDA and its influential factors mentioned above. The conclusions of this study are: (1) the curves of consumers' basic characteristics versus adoption of MDA are convex-type. (2) The consumers' age, name-list size, innovation adoption, goal-oriented and Internet usage frequency attributes have direct and positive effects on PDA adoption. (3) The innovativeness of consumers may be used to explain the reason of Consumers' procurement style. (4) The innovativeness of consumers may be used to exploit and design the product differentiation strategy. (5) The basic characteristics of consumers may be used to exploit and design the promotion and market segmentation strategies.

## 1. Introduction

As Internet gets widely used and digital devices get smaller and smarter, information appliances (IA) that are mobile, lightweight, versatile become popular and essential in market to suit for knowledge users daily usage. Although many products are named information appliances, the mobile digit assistant (MDA) is the representative category.

Consumer behavior is defined as the consumers' behavior to search, evaluate, procure, use and process some products, services and ideas. However consumers have many facets which affect the consumer adopting the MDA, like sex, education, occupation, innovativeness, attitude for impulsive or planning buying, the degree of Internet usage, etc. Many scholars apply single perspective to discuss consumer behavior. Like perspective of innovativeness [17], impulsive buying perspective [18] and information search perspective [21]. However since the fast progress of technology, the shorting of product life cycle, the highly changeability of consumers' demand, using single perspective to explain consumer behavior is not enough. Based on the consumer-oriented trend, this paper hopes to construct an integrated model to exploit the adoption MDA of

consumer behavior. Besides to understand more the consumer behavior when facing fast changeable or upgraded products, the conclusion of this paper also can provide more significant marketing strategy for the suppliers of MDA business.

## 2. Theory and Hypotheses

At past, some researchers view consumer behavior with focus on the action process of consuming [1] [14] [19]. Some other researchers refer consumer behavior as both the action process and the decision making process of consuming [3] [4] [24]. We may define the consumer behavior as "in order to satisfy ones need, consumers make consuming decision and take procurement action for some products or services". The processes include searching, evaluating, purchasing, and post purchase reevaluating. We may use the modified consumer decision model to describe the consumer procurement processes. And the basic characters of consumers (like sex, ages, education...) will affect the adoption of MDA.

Consumers' innovativeness and risk aversion also are very important factors for adoption of innovation products [2] [9] [15] [17]. Since Internet is a new channel for information search and procurement, the higher the perceived knowledge of Internet, the higher degree of Internet usage, and the higher the degree of MDA adoption. So the Internet perceived trend and Internet usage frequency are significant factors for adoption of MDA [11].

Impulsive buying is referring to impulsive, out of control and guilty procurement behavior [5] [16] [18] [22] [23]. Although the MDA procurement is also involved the impulsive character, the MDA buying behavior is based on need and affected by the mood at selling places, as well as sales and promotion strategy. We call this procurement behavior as "shopping around". The opposite procurement type is goal oriented buying [8]. Our research shows that both affect the adoption of MDA. The consumer's involvement is also an important factor on procurement of products and services [6] [13]. Especially from the perspective of information search [20] [21], the number of shopping mall, the number of brand and the number of product attributes are important factors of adoption MDA [10]. So, this paper uses

“brand-channel involvement” to represent the consumer involvement concept.

Mobile digital assistant (MDA) is referred to “the mobile digital equipment to assist and satisfy the customers’ life and work need”. In this research, we investigate the most technology and fashion influential products, namely, personal digital assistant (PDA) and cellular phone (CP). The objective of this research is to analyze the correlation between consumers’ adoption of MDA and some of its influential variables, namely innovativeness, procurement types, involvement, the degree of Internet usage and the basic characteristics of consumers.

The overall conceptual model of this paper is as figure.1. According to literature review, conceptual model and experience, we get two parts of hypotheses. One part is logic inference and the other is about conceptual model.

(1). Logic inference:

- H1: The curves of consumers’ ages versus adoption of MDA (PDA and CP) are first increasing then decreasing (convex-type), which should have a peak. The curve of consumers’ adoption of CP is higher than that of PDA.
- H2: The curves of consumers’ name-list-size versus adoption of MDA are convex-type. As consumers’ name-list-size increases, the number of PDA consumer is higher than that of CP consumer.
- H3: The growth curve of innovativeness of MDA is from bottom to up (market-oriented). The curve of CP adoption is closer to the diffusion of innovation theoretic curve than that of PDA.
- H4: For Internet users, the curve of consumers’ ages versus Internet usage frequency is convex-type, which should has a peak. But for non-Internet customers, the degree of Internet usage frequency decreases as the customers’ age increases.

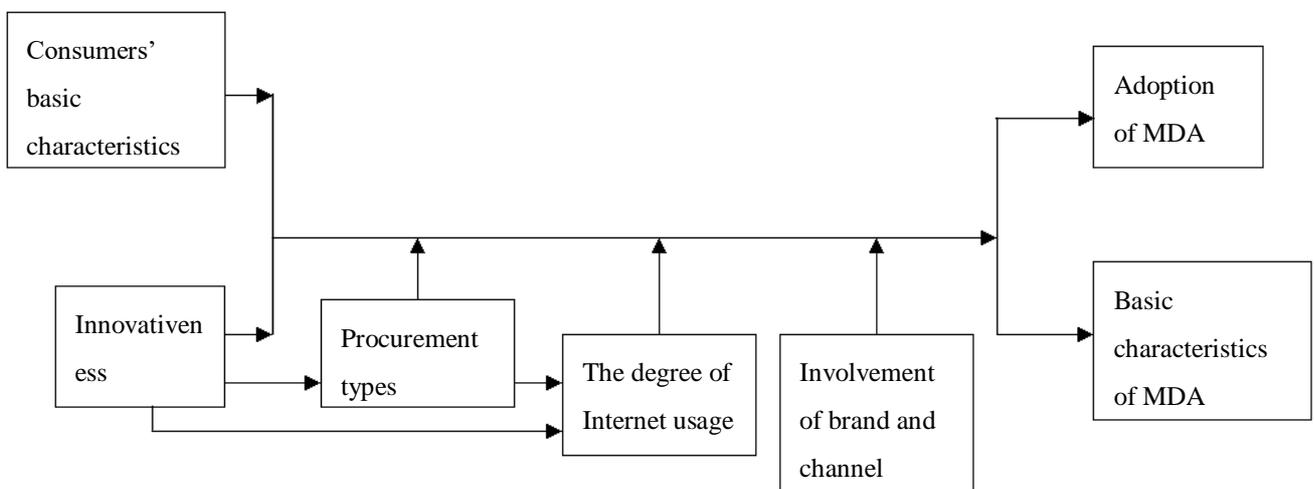
H5: As the degree of consumers’ goal-oriented increases, the Internet usage frequency increases. As the degree of consumers’ shopping-around increases, the Internet usage frequency increases.

(2). Conceptual model:

- H6: The adoption of MDA (PDA and CP) is no related with the consumers’ basic characteristics.
- H7: The adoption of MDA (PDA and CP) is no related with the consumer’s innovativeness.
- H8: The adoption of MDA (PDA and CP) is no related with the consumers’ procurement types.
- H9: The adoption of MDA (PDA and CP) is no related with the consumers’ Internet using frequency.
- H10: The adoption of MDA (PDA and CP) is no related with the consumers’ brand-channel involvement.
- H11: When adoption the MDA, the consumers’ innovativeness is no related with their Internet using frequency.
- H12: When adoption the MDA, the consumers’ innovativeness is no related with their procurement types.
- H13: When adoption the MDA, the consumers’ innovativeness is no related with the product and channel characters of MDA.
- H14: The consumers’ basic characteristics are not related with the product and channel characters of MDA.

3. Data and Research Method

This paper provides a new model to explain the influence effects between consumers’ adoption of MDA and its influential factors mentioned above. For effectiveness and cost consideration, this research using convenience sample. We totally sent 477 questionnaires and received 352 effective ones since 2001/4/20 to 2001/5/11. From 86 of these (24.4%), we received questionnaires from customers who both use the PDA and CP. From 307 of these (87.2%), we received questionnaires from customers who only use the CP.



Figuer1 : The overall conceptual model

The coefficients of reliability (Cronbach'  $\alpha$ ) for the variables (innovativeness, procurement types, etc.) are above 0.7 [12]. To test the construct validity of questionnaire perceptual measure, we use regression analysis and ANOVA. The coefficients of these relations are significant ( $p < .05$ ).

To test the conceptual model and corresponding hypothesis, we use LISREL model ( $\eta = \Gamma \xi + B \eta$

+  $\zeta$ , significant with GFI=.88, CFI=.93 and NNFI=.89), factor analysis, ANOVA and canonical correlation analysis.

#### 4. Results and Discussions

The results of testing hypotheses are summarized in tables 1 and 2.

Table1 Logic inference hypotheses testing table

Hypo	Relation	Results	Commend / Explanation
H1	Consumers' age vs. the adoption of MDA	Partial support	(1) Peaks are all at ages of 26~30 ; (2) Cp is higher than PDA ; But (3)peaks of CP and PDA at the same age level.
H2	Consumers' name-list-size vs. the adoption of MDA	Support	(1) Cp peak at no.25~34, PDA peak at no.21 ; (2)The name-list-size larger, the percentage of adoption PDA higher.
H3	Consumers' innovativeness vs. the adoption of MDA	Support	(1) The growth curve of innovativeness of MDA is market-oriented ; (2) The curve of CP adoption is closer to the diffusion of innovation theoretic curve than that of PDA.
H4	Consumers' age vs. Internet using frequency	Support	(1) For Internet users, the curve is convex-type and the peak at ages of 25~35 years old ; (2) For non-Internet users, the degree of Internet using frequency decreases as the customers' age increases.
H5	Consumers' procurement type vs. Internet using frequency	Partial support	(1) The goal-oriented users' Internet using frequency is higher than the shopping around users ; (2) The higher the degree of goal-oriented, the higher the Internet using frequency ; (3) But as the degree of consumers' shopping-around increases, the Internet usage frequency first increases then decreases.

Table2 Conceptual model hypotheses testing table

Hypo	Details	Relations	Results	Commend / Explanation
H6	H6	Basic characteristics→adoption of MDA	Support	Significant effect to PDA
	H6-1	Basic characteristics→adoption of PDA	Support	Significant effect of age, name-list-size
	H6-2	Basic characteristics→adoption of CP	Not support	Cp is a popular product
H7	H7	Innovativeness→adoption of MDA	Support	Significant effect to PDA
	H7-1	Innovativeness→adoption of PDA	Support	Significant effect of Innovativeness adoption
	H7-2	Innovativeness→adoption of CP	Not support	CP is a popular product
H8	H8	Procurement type→adoption of MDA	Support	Significant effect to PDA and CP
	H8-1	Procurement type→adoption of PDA	Support	Goal-oriented has significant effect to PDA
	H8-2	Procurement type→adoption of CP	Support	Shopping around has significant effect to CP
H9	H9	The degree of using Internet→adoption of MDA	Support	Significant effect to PDA
	H9-1	The degree of using Internet→adoption of PDA	Support	Significant effect to PDA
	H9-2	The degree of using Internet→adoption of CP	Not support	Internet is no business with CP's function

	H10	Brand-channel involvement → adoption of MDA	Support	Significant effect to CP
H10	H10-1	Brand-channel involvement → adoption of PDA	Not support	To accumulate knowledge about new product, so not have to buy it
	H10-2	Brand-channel involvement→adoption of CP	Support	Significant effect to CP
H11	H11	Innovativeness→Internet using frequency	Support	Significant effect
H12	H12	Innovativeness→Procurement type	Support	Significant effect
H13	H13	Innovativeness→the attributes of MDA product and channel	Support	Significant effect to PDA, CP
	H13-1	Innovativeness→PDA product attributes	Support	Significant effect
	H13-2	Innovativeness→PDA channel attributes	Support	Significant effect
	H13-3	Innovativeness→PDA upgrade attributes	Support	Significant effect
	H13-4	Innovativeness→CP product attributes	Support	Significant effect
	H13-5	Innovativeness→CP channel attributes	Support	Significant effect
	H13-6	Innovativeness→CP upgrade attributes	Support	Significant effect
H14	H14	Consumers' basic characteristics→the attributes of MDA product and channel	Support	Significant effect to PDA, CP
	H14-1	Basic characteristics→PDA product attributes	Support	Significant effect
	H14-2	Basic characteristics→PDA channel attributes	Support	Significant effect
	H14-3	Basic characteristics→PDA upgrade attributes	Support	Significant effect
	H14-4	Basic characteristics→CP product attributes	Support	Significant effect
	H14-5	Basic characteristics→CP channel attributes	Support	Significant effect
	H14-6	Basic characteristics→CP upgrade attributes	Support	Significant effect

Some results of hypotheses test are not significant. We now discuss the results as follow:

- (1)H1 : The statistics results show not exactly consistent with hypothesis 1. The reasonable explanation is that the most frequently usage computer person is about 25-35 years old. So the percentage to use PDA is also higher. However Cp becomes a popular product. The age of 25-35 also becomes the highest fashion pursuing and friends-communication groups. So adoption of CP is also highest.
- (2)H5 : The statistics results show not exactly consistent with hypothesis 5. The reasonable explanation is that Internet benefits (ex. fast searching and quick ordering) are an essential incentive for goal-oriented consumers. Therefore the higher customers' degree of goal oriented, the higher which degree of Internet used. But for shopping around trend customers, Internet just one of many sources of information. Yet person-to-person interactions are more attractive for shopping around trend customers than Internet bothering problems (like long-run waiting time, security, no physical tying).

Therefore the higher customers' degree of shopping around, the lower which degree of Internet used.

- (3)H6-2 : The statistics results not support hypothesis H6-2. According MIC [7] data shows that Taiwan customers use about eighteen million CPs. Almost everybody has over one CPs. Therefore CP become an ordinary and popular product. No some groups (like age, occupation, grade, or incomes) are special cases for adoption of CP.
- (4)H7-2 : The statistics results not support hypothesis H7-2. As (1), CP becomes an ordinary and popular product. There is no problem of adoption of CP. Yet there is a problem of adoption of CP about what type, what color and what special price. So innovativeness has nothing to do with adoption of CP.
- (5)H9-2 : The statistics results not support hypothesis H9-2. The reasonable explanation is that PDA functions are similar to PC or notebook. But CP main function is to communicate. The correlation about computer and Internet seems not significant. Especially using WAP to

download data is very slow and expensive. So the degree of Internet used has nothing to do with adoption of CP.

(6)H10-1 : The statistics results not support hypothesis H10-1. We may from social-psychology perspective to explain this result. Since PDA is an innovation so far. Even many customers haven't the need to buy one. They also collect and search PDA information. They not only enjoy shopping but also gather new knowledge to become a market expert. Therefore the brand-channel involvement may not have direct effect in procurement of PDA.

## 5. Conclusion and Suggestion

The main finding of this study are as follows :

### 5.1 The distribution of consumers behavior

(1)The curves of consumers' ages versus adoption of MDA are convex-type, which have peak at 26~30 ages. The curve of consumers' adoption of CP is higher than that of PDA. The curves are as figure 2.

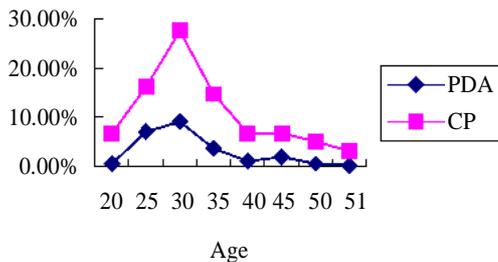


Figure 2. Consumer age and adoption of MDA

(2)The curves of consumers' name-list-size versus adoption of MDA are convex-type. As consumers' name-list-size increases, the number of PDA consumer increases, but that of CP consumer decreases. The curves are as figure 3.

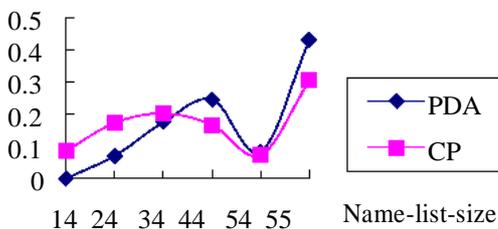


Figure 3. Consumers' name-list-size and adoption of MDA

(3)The growth curve of innovativeness of MDA is market-oriented. The curve of CP adoption is closer to

the diffusion theoretic curve than that of PDA. The curves are as figure 4.

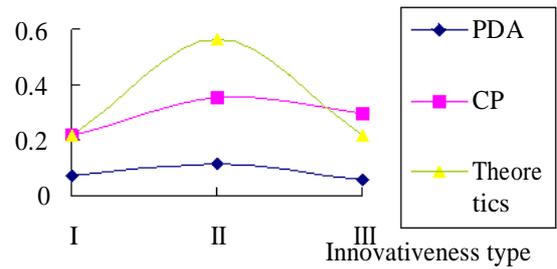


Figure 4. Consumers' innovativeness and adoption of MDA

(4)The curve of consumers' ages versus Internet using frequency is convex-type, which has peak at 26~35 ages. However, the elder age of consumers, the more rate of non-Internet user. The curves are as figure 5.

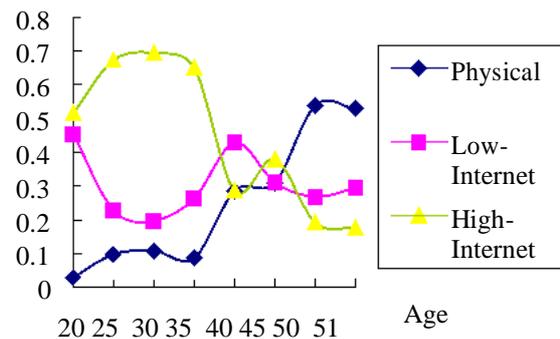


Figure 5. The customer's age and the Internet usage frequency

(5)The Internet usage frequency of the goal-oriented consumers is higher than that of the shopping-oriented. As the degree of consumers' goal-oriented increases, the Internet usage frequency increases. The curves are as figure 6.

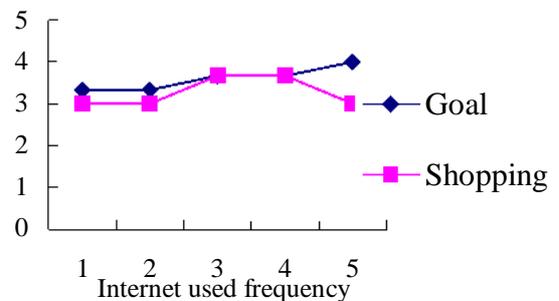


Figure 6. Procurement type and Internet usage

## 5.2 The results of statistics analysis

- (1) The consumers' age, name-list size, innovation adoption, goal-oriented and Internet usage frequency attributes have direct and positive effects on PDA adoption. The consumers' occupation, shopping-oriented and brand-channel involvement attributes have direct effects on CP adoption. The conclusions are summary in table 3.

Table 3. The summary of directly affective factors of adoption MDA

	Adoption of PDA	Adoption of CP
Age	X	
Occupation		X
Name-list-value	X	
Innovation adoption	X	
Risk aversion		
Goal-oriented	X	
Shopping around		X
Brand-channel involvement		X
Internet used trend		
Internet used frequency	X	

- (2) Innovativeness, procurement types and degree of Internet usage are intermediate variables.  
 (3) The innovativeness attribute of consumers has direct and positive effect on procurement type.  
 (4) The innovativeness and basic characteristics of consumers have statistical influence on MDA product

attributes, channel attributes and upgrade attributes.

The above findings are significant to the theoretical and managerial implication in the following aspects :

- (1) This research results are consistent with innovation diffusion theory, cost and efficiency theory and social-psychology theory of information searching.  
 (2) The innovativeness of consumers may be used to explain the reason of Consumers' procurement style.  
 (3) The innovativeness of consumers may be used to exploit and design the product differentiation strategy. Businesses may use new products, fashion style and high price strategy for consumers of high innovativeness, use brand-building, information service and advertise promotion for consumers of medium innovativeness and use brand-building, convenient procurement and low price strategy for consumers of low innovativeness. The conclusions are summary in table 4.  
 (4) The basic characteristics of consumers may be used to exploit and design the promotion and market segmentation strategies. For example, Businesses may offer high compatible and high expansive product for male or consumers of high innovativeness. Businesses may offer basic functional and integrated of hardware and software product for peoples ages from 46 to 50 or architects and builders or free-lancer or consumers of low innovativeness. Businesses may offer professional services and promotion for female or graduates or mouth incomes of seventy-eighty thousand or consumers of low innovativeness. Businesses may offer excellent repairs and guarantees for incomes of ninety-one hundred or consumers of low innovativeness, and offer additional information services and price discount which will produce more attractive effects for consumers of low innovativeness. The conclusions are summary in table 5.

Table 4. The summary of consumer's innovativeness and the degree of PDA product and channel attributes

PDA	Product attributes	Channel attributes	Upgrade attributes
Early adoption type	Product style (+) New/old machine (+) Chinese friendly (-)		
Early majority type	Famous (+) Size and function (+) Basic operation (-) Easy to use (-) Price (-)	Information service (+) Promotion (+)	Enlarging memory (+) Color LCD screen (-)
Late majority type	Price (+) Public praise of friends (+)	Price and discount (+) Store nearby (+) Convenience of return or exchange of goods (-)	

Table 5. The summary of consumers' basic characteristics and the degree of PDA product and channel attributes

PDA	Product attributes	Channel attributes	Upgrade attributes
Sex	Compatibility factor (male) Sources of information factor (female)		Compatibility factor (male)
Age	Function factor (46~50 years old)		
Education	Sources of information factor (graduate level)		Appearance and style factor (graduate level)
Occupation	Appearance and style factor (architects and builders) Function factor (architects and builders)		Compatibility factor (Bankers and insurer) Appearance and style factor (architects and builders)
Grade	Function factor (free-lancer)		
Income	Sources of information factor (70~80 thousand)	Excellent repairs and guarantees (90~100 thousand)	
Innovativeness	Compatibility factor (early majority) Function factor (Late majority) Sources of information factor (late majority)	Professional services and promotion (late majority) Excellent repairs and guarantees (late majority) Price discount (late majority)	

## Reference

- [1] Alderson, Wroe, Marketing Behavior and Executive Action, Homewood, Richard D. Irwin Inc., pp. 165-166, 1975.
- [2] Craig, C. Samuel, and Ginter, James L., "An Empirical Test of a Scale for Innovativeness," In Mary Jane Schlinger (Ed.), Advances in Consumer Research, Vol. 2, pp. 555-562, 1975.
- [3] Demby, Emanuel, Psychographics and Form Where It Comes in Lifestyle and Psychographics, William D. Wells Edition, Chicago, AMA, pp.22, 1974.
- [4] Engel, James F., Kollat, David T. and Blackwell, Rogers D., Consumer Behavior, 6th Edition, Chicago, Dryden Press, 1993.
- [5] Faber, R. J. and O'Guinn, T. C., "Impulsive Consumption and Credit Abuse," Journal of Consumer Policy, 11, pp.419-433, 1988.
- [6] Goldsmith, R. E. and Emmert, J., "Measuring Product Category Involvement: A Multitrait - Multimethod Study," Journal of Business Research, 23, pp.363-371, 1991.
- [7] Information industry institution, Market information center, <http://mic.iii.org.tw/>
- [8] Janiszewski, Chris, "The influence of display characteristics on visual exploratory search behavior," Journal of Consumer Research, Gainesville; Vol. 25, Iss. 3, pp.290-301, Dec 1998.
- [9] Leavitt, C. and Walton, J. R., Openness of Information Processing as a Moderator of Message Effects on Behavior (Faculty Working Paper). College of Business Administration, Ohio State University, 1988.
- [10] Lee, M. S. and Banwari, M., "A Causal Model of Consumer Involvement," Journal of Economic Psychology, 10, pp.363-389, 1989.
- [11] Lee, C. C. and Yu, C. S., "An Analysis of Consuming Behavior for Information Assistants—From Innovativeness perspective, the Case of PDA," Journal of National Taipei College of Business, Vol.1, 2001.
- [12] Nunnally, J. C., Psychometric Theory, New York : McGraw-Hill, 1978.
- [13] Petty, R. E. and Capicoppo, J. T., "Issue Involvement as a Moderator of the Effects on Attribute of Advertisement Content and Context," Advances in Consumer Research, 8, pp.12-40, 1981.
- [14] Pratt, Jr. W. R., Measuring Purchase Behavior in Handbook of Marketing, Robert Ferber Edition, New York, McGraw-Hill Co., 1974.
- [15] Price, L. L. and Nance M. Ridgway, Development of a Scale to Measure Use Innovativeness, In Richard P. Bagozzi and Alice M. Tybout (Eds.) Advances in Consumer Research (Vol. 10, pp.679-684). Ann Arbor, MI: Association for Consumer Research, 1983.
- [16] Puri, R., "Measuring and Modifying Consumer Impulsiveness: A Cost-Benefit Accessibility Framework," Journal of Consumer Psychology, 5(2), pp.87-113, 1996.
- [17] Rogers, E.M., Diffusion of the Innovations, 4<sup>th</sup> ed., The Free Press, New York, NY, 1995.
- [18] Rook, D. W. and Fisher, R. J., "Normative Influence on Impulsive Buying Behavior," Journal of Consumer Research, 22(Dec.), pp. 305-313, 1995.
- [19] Schiffman, L. G. and Kanuk, L. L., Consumer Behavior, 2<sup>nd</sup>, Engewood Cliffs, New Jersey, Prentice-Hall, 1991.
- [20] Schmidt, J.B. and Spreng, R. A., "A Proposed Model of external Consumer Information Search," Journal of the academy of Marketing Science, Vol. 24, No.3, 1996.
- [21] Srinivasan, N. and Ratchford B., "An Empirical of Test of a Model of External Search for Automoniles," Journal of Consumer Research, Vol. 18, pp. 233-242, 1991.
- [22] Stern, H., "The significance of Impulsive Buying Today," Journal of Marketing, 26(April), pp.59-62, 1962.
- [23] Valence, G., d'Astous A. and Fortier, L., "Compulsive Buying: Concept and Measurement," Journal of Consumer Policy, 11, pp. 419-433, 1988.
- [24] Walter, C. G. and Gordon, P. W., Consumer Behaviors: an Integrated Framework, Homewood, III, Richard D. Irwin Inc., 1970.

# Mobile Internet based M-Commerce Management Architecture & System \*

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## Abstract

The mobile Internet exists already in very many forms on the market. However, there are definitely still a lot of possibilities to improve the current concepts and solution, and thus a lot of room for future R&D activities. This paper is divided five parts as followings:

First of all, introduction; Secondly, the basic concept of mobile Internet is introduced, and its' development status is described simply; Thirdly, the process of come into being M-commerce based on Internet and the existing modes of M-commerce are discussed respectively; the differences between E-commerce and M-commerce are also shown in the paper; Fourthly, an M-commerce system model is presented, the model involves its' basic elements such as hierarchical architecture, management mechanism, system decision-making, application procedure etc; Fifthly, development trend and application fields for coming the new economics times are forecasted; Finally, how to build a M-commerce management system and make applications for business via CERNET\*\* (one of the biggest Internet platform in China) are introduced primarily in end of the paper.

## 1. Introduction

The booming Internet provides to people many conveniences and unlimited business chances. E-commerce has well known, for example, is one of the modern business models, nevertheless novelty mobile Internet is emitted today along with developing Internet & mobile communication technologies as well as people's imperious demands progressively. However, the mobile Internet is enlarging application fields of Internet-based E-commerce, at the same time, it opens up another way for suiting the future business. Therefore the mobile Internet-based named M-commerce (mobile commerce) is appeared slowly in the forefront of new economics times as a novel commerce mode. Nowadays "Mobile" has used widely in many fields with correlative daily life, such as mobile finance, mobile office, mobile mailbox, mobile classroom, mobile hospital, mobile bank, mobile phone, mobile computer, as well as mobile battle ..... so many "mobiles," they are popular in kinds of social and economical fields, and more and more press close to people's daily life, their mutual "mobility" is achieved by the mobile Internet. So we can regard justly the M-commerce as a capacious stage for the future business based on developing rapidly Internet, it is not only a

novel business mode but also a landmark effecting home social development and human behavior, and it can also supply an opportunity to span some stages of economical development for the developing countries.

In the near years, E-commerce has been discussed widely despite there isn't uniform appraise. However in the modern information society, E-commerce is an inevitable result of technique development and society progress, on the other hand it is also an innovation special for the developing counties, and its' progress is suffocated because of its' juvenility and imbalance in the global information industry. Whereas E-commerce is one of important step for the inevitable global information process, it is the means resource of new economics. In the new economics times, M-commerce will become a main mode of E-commerce, hereby it is important and necessary that understand and research M-commerce facing the coming "mobile times".

## 2. Mobile Internet and Its' Current Status

Mobile Internet is a large-scale and expansive application platform that be consisted of mobile communication system and Internet architecture, as well as relative advanced information technologies. The current status of M-commerce is shown by some characteristics as followings: Firstly, the M-commerce services is mushrooming to become a large-scale industry in some developed countries, but it is very imbalance over whole world, especially for developing countries such as the poor Africa country; Secondly, so far there isn't an integrated system architecture & uniform management model for M-commerce in the world; Thirdly, some factors such as techniques, management, society credit system, and so on, they can't yet ensure absolutely the reliability of some M-commerce applications, this is a very important factor that restrict farther development and enlarging application fields of M-commerce in the future. Fourthly, lack of uniform fare rules, for example, there isn't fair and reasonable model for measuring all M-commerce trades between company and company or company and customer, the existing incomplete model can't accept by all traders and customers yet.

## 3. Existing M-Commerce Mode

"Limited fast-moving" is an important character of existing M-commerce mode. The existing M-commerce mode is developed mainly from the original shape based



mobile interconnection, transmit speed and stability are not satisfied enough, input difficulties yet no solution and there is no rich, effective applications. If we cannot solve these problems, mobile Internet could only be remaining as a concept to affect M-commerce farther develop.

Altogether, some key factors for the M-commerce development in China could then be summarized as:

★ With the popularization, charge rate will become more and sensitive to utilization of M-Internet.

★ New technologies will bring opportunities for M-commerce.

★ Regulation policy and business model are both key issues for the growth of M-commerce in China.

## 6. CERNET Introduction

CERNET [6] is one of the biggest Internet platforms in China. Nowadays, the network is consisted of 8 GigaPop center nodes, 36 MigaPop main nodes, connecting cities over 160, members over 900, users over 9 million (latent users over 320 million). There are many testbeds such as IPv6 testbed between China and Japan, 3Tnet, NSFCNET, CERNET and CERNET2, they are connecting to Internet2 and APAN ect., it will become one of the most important application platform for M-commerce in the future in China.

## References

- [1] <http://www.lhtelecom.com.cn/accept/intel/169/ngi.htm>
- [2] <http://www.chinamobile.com/main/default.asp>
- [3] Zeng Q.H., HSA Information Processing System, Computer Engineering & Science, Vol.18 (11), 1996: 229-231
- [4] Zeng Q.H., Chinese NGI Development Plan Report, Chart 3.
- [5] Lu T.J., E-commerce and M-commerce in China. 2002 Euro-China Co-operations Forum on the Info.Society Proceedings
- [6] <http://www.edu.cn>

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\*\* CERNET means China Education and Research Network (CERNET for short)

## Autobiography

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He is currently a member of IEEE, IEEE-CS and CSEE. He is also a senior member of CSSE. He was awarded the top paper prize in information management engineering from National Information Center of China and second research prize in computer control and its application in electronics and information systems from CSEE, and top doctoral prize from Huazhong University of Science & Technology and the top graduate student prize from The Eastern Communication Co., LTD., He has published more than 50 papers in domestic and international journals such as IEEE, IEE, ICEE, Chinese Journal of Electronics, Computer Application, System Engineering, Decision Science & Application, High Technology Letter, Computer Engineering & Application and the proceedings of International conference on Management/Telecom/Industrial/ Engineering ect..

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